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REAR-ADMIRAL JASPER H. SELWYN, Member of Council, in the Chair.

ON THE PRINCIPLES WHICH SHOULD GUIDE THE CONSTRUCTION OF HEAVY ORDNANCE, AND ON THE MATERIALS FOR THE SAME.

By JAMES A. LONGRIDGE, M. Inst. C.E.

THE construction of heavy ordnance is a subject which at the present time possesses especial interest in this country, and the more so because of the recent accident on board the "Thunderer."

In a recently published letter addressed to the First Lord of the Admiralty, I have dealt with the case of the exploded gun, and with the report made thereon by the Committee of Inquiry; and without entering further into this question I may be allowed to express the hope that a thorough investigation of the subject may be made, and such experiments instituted with the other 38-ton gun, as will set at rest the contention raised in regard to this accident.[1]

The matter is one of the highest national importance, because *if the Committee are right* it points to the conclusion that such a fearful accident is possible, *not* in the heat of action when the gun's crew may naturally be excited, and when it would probably consist of men of only average proficiency and steadiness of drill; but on the contrary with a picked crew, under the direction of specially trained officers and during the peaceful operation of firing two or three rounds at a target.

[1] These experiments are being carried out.—ED.

But not to go further into this, I will only add that if my contention be correct, viz., that the shot jammed in the bore of the gun, the country has to deal with a very serious position, inasmuch as what has happened on board the "Thunderer" may happen any day again.

Therefore it is that the question of construction has at this time such an absorbing interest, and in dealing with it I shall confine myself as far as I can to general principles rather than to details, which, were they at all adequately dealt with, would occupy far more time than is to-day at our disposal.

It may seem presumptuous in me to address such an Instiution as this on a subject of this nature, but in truth it is one which is peculiarly within the province of the Mechanical Engineer.

A gun is just as much a machine as is a hydraulic press or a steam-engine. It is a machine in which labouring force is generated and applied to the transport of a mass of matter to a distance at a high velocity and against considerable resistance. This machine must, like all other machines, be made of material that will resist the strains to which it is subjected, and that material ought to be so placed as to do its duty in the most efficient manner.

Consequently the construction of such a machine is just as much a problem concerning the Engineer as is that of any other machine or structure with which he has every day to deal.

If, for instance, he has to design a bridge to carry a given load over a span of 400 or 500 feet, or a locomotive engine to draw a load of 1,000 tons at a given velocity, it is not his practice, if he understands his profession, to proceed by any tentative process or rule of thumb as it is called, but he has recourse to proper formulæ, according to which he determines the proportions of every part of his design, and which enable him to work with confidence and success.

Take, for instance, a wrought iron bridge, carrying a railway over a ravine, he is bound down by fixed rules by the Board of Trade that no portion of the material in his structure shall be strained beyond certain limits of tension or compression, and where would he be, and where would be the interest of his employers, if he had no formulæ to guide him, or if he disregarded them and groped his way by a tentative process founded upon his former experience?

In a paper recently read at the Institution of Civil Engineers, I at some length criticised the Woolwich practice as set forth in the Official Red Book of 1877, and showed that by their own admission, the authorities there are guided by no formula.

In fact, as Sir H. Lefroy said[1] "they had discarded formulæ "and had adopted practical rules of thumb, and he thought it might "be reasonably concluded that they had some justification in doing "so."

Such being in fact the case, I must once more take this opportunity of objecting to such a course as unscientific and calculated to lead to unsatisfactory results.

[1] Minutes, Proceedings Inst. C. E. Vol. lvi, Part II, p. 37.

I propose in this present paper to direct your attention to the following divisions of the subject:—

1st. The nature of the force with which we have to deal.
2nd. The material which has to control and direct that force.
3rd. The proper disposition of that material.
4th. The arrangement for giving the projectile the necessary rotation.
5th. The effect of chambering.
6th. The proper arrangement of the material in the construction of breech-loaders.

1*st. The force with which we have to deal.*—This is the force of fired gunpowder. Many other explosive compounds have been proposed, but I believe it is now universally admitted that gunpowder is that which is best suited for artillery purposes.

Here, however, we are met with the fact that there are many varieties of gunpowder. These, however, as regards our own service, may be confined to R.L.G. and pebble powders, the latter being that which is now solely used in heavy guns.

The advantages claimed for pebble powders are that whilst they give as great or a greater muzzle velocity they cause a less strain upon the gun than the R.L.G.

That they cause a less strain is quite true, and is due to the fact that they burn slowly and continue burning whilst the projectile is moving towards the muzzle.

It may, however, be shown that with *a given weight* of powder the mean pressure is less with a slow than with a quick burning powder.

Taking the pressures in the 10-inch gun fired with 75 lbs. of pebble powder and a 300 lb. shot, of which a diagram is given in Messrs. Noble and Abel's paper on fired gunpowder (Phil. Trans. 1875), we find that with a maximum pressure of 18 tons per square inch, the terminal pressure at the muzzle was 3 tons, and the mean pressure about $6\frac{1}{2}$ tons per square inch.

Now when the shot reached the muzzle the chase was filled with gas at a pressure of 3 tons per square inch. If now that gas were pressed back by a piston until it occupied the original volume occupied by the charge, and if there were no transmission of heat, which, as I will presently show, would be the case, the pressure would rise to 33·63 tons per square inch. But the work done in compression would be exactly equal to that given out in expansion, so that if the charge had been converted into gas *instantaneously*, the chamber would have been filled with gas at 33·63 tons, and that gas in expanding to 3 tons would have given a mean pressure of $9\frac{1}{2}$ tons per square inch against $6\frac{1}{2}$ tons per square inch given by the pebble powder.

Roughly speaking, if the powder had been instantaneously converted into gas, the velocity of the shot would have been increased by twenty per cent., but this would have been obtained by an increase of pressure in the gun, from 18 to 33·63 tons, or about 86 per cent.

It is therefore evident that with the same weight of charge there is a loss of velocity with slow burning powder.

This appears to be borne out by the experiments recorded by the Committee on Explosives (Second Report, page 9), where the velocity obtained in a 12-inch gun with 85 lbs. pebble powder was 1,287 feet per inch, and with 67 lbs. R.L.G., 1,157 feet per inch.

If the charge of R.L.G. had been 85 lbs., the velocity would have been 1,304 feet per inch, or about three per cent. greater than with the pebble powder, and a similar result would be obtained from the experiments recorded at page 10 of the Preliminary Report made with a 10-inch gun and charges of 60 lbs. of R.L.G., and 70 lbs. of pebble powder.

The difference of velocity between these powders is, however, so small that there can be no doubt of the wisdom of using the slow burning powder in large guns as at present constructed.

This being so, we may assume that we have for our motive power an elastic fluid attaining a pressure of 20 to 24 tons per square inch in guns of 12 inch diameter, and possibly 30 tons in larger guns.

I may, however, mention that the powder in use in the United States of America, appears to give considerably lower pressure than our pebble powder.

In Captain E. Palliser's Report on United States Artillery, 1879, the pressures are given for an 8-inch gun with one solid shot with a charge of 20 lbs. powder pressure .. 9·26 tons per square inch,
With a charge of 35 lbs. „ „ .. 13·39 „ „ „
and in the official report of the Chief of the Ordnance for 1875, the pressures in a 9-inch gun with projectiles varying from 215 lbs. to 230 lbs. found, were as follows:—

Charge.	Pressure in tons per sq. in.
25 lbs.	7·25
30 „	8·70
35 „	10·00
40 „	12·00
45 „	12·86
47 „	13·90

These experiments, among others, point to a large increase of pressure when the charge is increased.

This was maintained many years ago in the face of much opposition by Mr. Lynall Thomas, and it appears that there can be no doubt of the fact, but as far as I know the law of increase yet remains undetermined.

What regards us, however, at present, is that we must provide for much higher pressures in large guns, even though we do adopt slow-burning powder.

The next point to which I will call your attention, is the material of which the gun is to be made.

For heavy artillery we may leave bronze out of the question and confine ourselves to cast iron, wrought iron, and steel.

Much confusion of idea arises from the want of a really scientific nomenclature on this subject. By many writers, iron and steel are

treated almost as though they were distinct metals, whilst the fact is that iron, whether cast or wrought, and steel, are in all their varieties only alloys of the metal iron with other substances.

All the innumerable varieties of properties, such as hardness, ductility, elasticity, tensile form, and resistance to compression, are due to specific mixtures of one or more substances with pure iron, and to particular modes of treatment in the process of manufacture, and consequently there can be no doubt that with exact knowledge of the properties of various mixtures and complete uniformity in the progress of manufacture, we would be able to produce with certainty any of the possible combinations which we might require.

How very far from this we still are, all practical men well know; but at the same time it cannot be denied that of late years enormous progress has been made, and that much of the uncertainty which obtained both in the manufacture of iron and steel, is now done away with.

It is practically impossible to draw an exact line between iron and steel. If we had a piece of pure iron, by adding to it carbon, we should form an alloy which would gradually acquire the property of tempering and become more fusible, and as we went on increasing the carbon, we should come to cast iron incapable of being tempered but more and more fusible. Other substances added with or without the carbon will give alloys of other properties, and as I have said before, were our knowledge sufficiently extensive and our processes perfect, we could with unfailing regularity produce the mixture we required.

I will not detain you with any detail of the properties of iron and steel as now used for ordnance, but will only advert briefly to two points of much interest.

The first is Sir Joseph Whitworth's process of subjecting steel to intense pressure whilst in the liquid state, whereby its consolidation is effected much more perfectly than by any process of forging. I have no hesitation in saying that for all purposes where a uniform quality combined with great strength is required, such as is the case in the construction of guns, Sir Joseph's process is far preferable to that employed at Woolwich for the steel tube.

It also ought to be more economical, since in the one case the tube is cast hollow, in the other, cast forged, and then bored out of the solid.

The other point to which I would advert is the effect of tempering in oil. Here it appears to me that we are sadly deficient in information. The experiments which have been made in this country show a great increase in the ultimate strength of steel tempered in oil, and under certain conditions an increased capacity for stretching before rupture, depending it would appear upon the temperature at which the cooling takes place.

But on the important question of the effect upon the modulus of elasticity and the limit of the elastic range, no reliable experiments have, as far as I know, been made in this country.

I am indebted to the Compagnie des Forges et Fonderies de Terre

Noire for the results of some very valuable experiments made on steel of their production for the Paris Exposition of 1878.

The following Table contains a *résumé* of the effect of tempering in oil and in water on various qualities of steel containing from 0·150 to 1·050 per cent. of carbon as regards the following properties :—

1st. Limit of elasticity.
2nd. Ultimate strength.
3rd. Amount of stretching at rupture.

Effect of tempering in oil and water on Steel Bars containing varying proportions of Carbon.

Bars 14 mm. square.

Percentage of carbon.	Limit of Elasticity.			Rupture.		Stretching at rupture.	
	Natural state.	Oil.	Water.	Oil.	Water.	Oil.	Water.
·150	100	149	140	131	137	84	56
·490	100	170	173	144	161	50	10
·709	100	215	Broke in tempering.	158	Broke in tempering.	27	Broke in tempering.
1·050	100	265	,,	143	,,	Broke.	,,
		Bars 20 mm. square.					
·150	100	172	182	129	138	73	68
·490	100	190	214	148	163	51	34
·709	100	220	Broke in tempering.	142	Broke in tempering.	15	Broke in tempering
·875	100	237	,,	143	,,	10	,,
1·050	100	235	,,	152	,,	22	,,

All the above results are strictly comparative. The material in its natural state is taken as 100.

From this we may deduce the following conclusions :—

1st. As regards the limit of elasticity, it appears that with bars of 14 mm. square the effect of tempering low steel of 0·150 carbon was to increase its limit of elasticity if tempered in water 40 per cent., and if tempered in oil 49 per cent., whilst with larger bars of 20 mm., the increase was 82 per cent. in water, and only 72 per cent. in oil. On the other hand, with 1·050 per cent. carbon, the effect of tempering in oil was to increase the limit of elasticity by 165 per cent. in the small bars, and 135 per cent. in the larger ones.

2nd. As regards ultimate strength, the effect with low steel was an

increase of 37½ per cent. by tempering in water, and 30 per cent. by tempering in oil. Whilst with high steel of 1·050, the effect of oil tempering was to increase the strength about 50 per cent. The bars failed when tempered in water.

3rd. As regards the amount of stretching at rupture, the result of tempering with low steel was, when compared with the steel in its natural state, a decrease of 44 per cent. in water, and 26 per cent. in oil, whilst with high steel the effect of tempering in oil was to reduce it from 80 to 90 per cent.

The bars of high steel containing 0·7 per cent. of carbon and upwards, broke in the tempering when water was used.

I wish to direct your attention specially to these results, as the conclusions in respect to the effect of tempering in oil upon the stretching capacity of the material is quite at variance with the generally held opinion.

Tempering in oil did not increase but decreased the extensibility of steel.

The steel in its natural state, that is to say untempered, had an extensibility of 100.

Steel of 0·150 per cent. carbon, tempered in oil, lost 27 per cent., and

Steel of 1·050 per cent. carbon, tempered in oil, lost 78 per cent. of this property.

It is often reported that the steel suitable for gun-making must be a low steel, because although a high steel acquires a much greater increase of the limit of elasticity, and a somewhat greater ultimate strength, yet its powers of elongation are very much less than that of a low steel.

But if by a proper disposition of the metal, we can insure the strain never exceeding a limit considerably within the limit of elasticity, then we might safely use a much higher carbonized steel and obtain the advantage of its high elastic power and great ultimate strength.

Laying down as a first principle of construction that no portion of the gun should under any circumstances be strained beyond its elastic limit, we find that this limit is reached in low steel of 0·150 per cent. at about 32 kilogrammes per square millimetre, or about 20 tons per square inch, whilst the ultimate strength is about 30 tons per square inch.

On the other hand, with a steel of ·709 per cent. carbon, the elastic limit is 43 tons per square inch, and the ultimate strength is 65 tons per square inch.

The steel used in the Woolwich tubes is stated in the Red Book (page 14) to contain 0·3 per cent. of carbon. I am of opinion that this is too little, and that a much stronger gun would be obtained by a steel containing about double this proportion of carbon, *provided in other respects the gun were properly constructed.*

Before, however, determining this proportion, a series of accurate experiments should be made, such as were made by the Terre Noire Company, but embracing also the temperature at which the tempering was effected, a point which does not appear to have been recorded in the Terre Noire experiments.

I have a strong impression that the temperature at which the steel is immersed in the tempering fluid will be found to have a considerable effect in the result, and so far as I know, this has not yet been accurately ascertained.

That steel is a far superior material to ordinary wrought iron I have no doubt at all, and it appears to me that it would be preferable even as a matter of economy.

It is not the first cost of the raw material that is to be considered, but the cost in the finished state, and when we find that the actual cost of a 38-ton gun at Woolwich is £90 per ton, it is very probable that a gun of the same weight made entirely of steel would not be more expensive and would be greatly stronger.

When I come, as I shall do presently, to the question of construction, I will show that a gun of equal strength may be made much lighter of steel than of iron, and the dead weight required to meet the recoil may be made up of a much cheaper material, so that in fact the steel gun may be made actually cheaper than the iron gun, and very much stronger.

As regards wrought iron, there are so many varieties differing so widely in those properties that I can do no more than point out what are the main features to be attended to in the selection of iron for gun-making.

These are :—

1st. The degree of extensibility per ton per square inch up to the elastic limit.

2nd. The elastic limit itself.

3rd. The amount of stretching before rupture.

4th. The amount of permanent set.

It will appear when I come to treat of actual construction, that in *all built-up guns* a high range of elastic limit is of primary importance, and whatever has been held to the contrary, I maintain that a great amount of stretching, *if accompanied by permanent set*, is a property to be carefully avoided in such guns.

This will be specially seen when I come to treat of Sir William Palliser's system where an iron of extensive stretching capacity seems to be preferred for the inner tube.

On comparing the results of the testing of some of the iron as given in the Official Report of the Chief of Ordnance, United States Army, 1876, I was greatly struck with this characteristic. The iron is called "Ridsdale," being as I believe that generally manufactured for gun-making by Sir William Armstrong and Co. I find that permanent set began under a strain of about 11 tons per square inch; that up to that point the extension was ·0017 *l.* or ·000155 *l.* per ton, which gives a modulus of elasticity of only 6,660 tons, whilst the permanent set at $14\frac{3}{4}$ tons per square inch is ·015 of the length, or ·001017 *l.* per ton, or rather more than $\frac{1}{1000}$th of its length per ton.

Comparing this with other sources of information, I find the permanent set of average wrought iron as follows :—

"The useful Metals and their Alloys," by Sir W. Fairbairn and others.

Bar of 10 feet long under strain of 13·26 tons per square inch gave a permanent set of ·043 inches = ·000366 *l.*, or ·0000276 *l.* per ton per square inch.

Again, according to the results recorded by Mr. Edwin Clark in his work on the "Britannia and Conway Bridges, 1850" (vol. i, p. 373) the permanent set under a strain of 13 tons per square inch was ·0002598 *l.* or 0·00001998 *l.* per ton per square inch; and for a strain of 14 tons per square inch, 0·000079 *l.* per ton per square inch; and for a strain of 15 tons per square inch 0·000191 *l.* per ton per square inch.

Comparing Edwin Clark's results with those given by the American Ordnance Department for the Ridsdale Iron, We find:—

Permanent set per ton per square inch in terms of the length

English Irons .. .. ·000163 *l.*

Ridsdale Iron, per American Ordnance Report ·001070 *l.*

Showing that the permanent set with the Ridsdale Iron is $6\frac{1}{2}$ times greater than that given by Mr. Edwin Clark.

On the other hand at 19 tons per square inch we find the permanent sets:—

English Iron according to Edwin Clark .. 0·000978 *l.*

Ridsdale American Ordnance .. .. .. 0·002530 *l.*

or only about $2\frac{1}{2}$ times as great.

It is not impossible that these great discrepancies may be due to the peculiarities of the different irons experimented upon, but if so it becomes only the more imperative that in building up such a structure as a gun the actual qualities of the materials used, should be experimentally ascertained, and that if possible the structures should be so proportioned that those only of the physical properties of the material should be called into play, which are best known and most accurately determined; and in saying this, I refer especially to the rule I have already laid down, that no material in a gun should ever be strained beyond its elastic limit, and as a corollary that any system of construction which depends upon the self-adaptation of its parts by overstraining and consequent permanent set, is to be strenuously avoided.

With these remarks I now come to the 3rd division of my subject, viz., "the proper disposition of the material," and I will deal briefly in the first place with the homogeneous gun, which in its usual condition is a solid gun made up of but one piece, such as the ordinary cast iron, bronze or steel guns.

I do so, although I believe few people would now advocate making a heavy gun in this way, because it involves the fundamental principle upon which all built-up guns must be founded, viz., the problem of determining the exact condition of strain of any particle of a cylinder which is subjected simultaneously to external and internal pressure.

In the solid homogeneous gun the external pressure is only that of the atmosphere, and that is so small when compared with the internal pressure that it may be neglected, but in built-up guns it is only the external ring which is so circumstanced, whilst all the others have

during explosion certain normal pressures at both surfaces depending first on the internal or powder pressure, and secondly on their relative dimensions previous to putting together and on the elasticity of the materials.

If these elements be known, the strains on every portion of the structure may be accurately determined, or on the other hand if it be required to construct the gun so that these strains shall not exceed a given limit, under any given powder pressure, then by the use of a proper formula the dimensions of the various parts of the structure required to fulfil this condition may be determined.

I wish to insist particularly on this because it is too often asserted that such formulæ are of no utility in comparison with practical experience, a thesis which no scientific man can hear propounded without astonishment.

It cannot be too strongly affirmed that formulæ are but the expression in accurate language of physical law; and yet we find it asserted by the Woolwich Authorities, as it is in their last Red Book, that the law of the distribution of strains "is not exactly known," that there are two laws the results of which vary from each other by 60 per cent. and that one of them which is indisputably wrong is simpler than the other, and yet that its results have been shown to be fairly trustworthy in practice, and yet again in the same sentence that the actual tension "probably lies somewhere between the two "results."[1]

When we find such statements made in a Book prepared by the Superintendent Instructor of the Royal Gun Factories and published as lately as 1877 by order of the Secretary of State for War and which Book professes to be a Treatise adapted for use more particularly by Officers who wish to enter somewhat into the theory and details of construction, what is the conclusion which we are compelled to arrive at, but that gun construction as practised at Woolwich is based on no sound principles and is a tentative process, and like all other tentative processes must be fertile in extravagant outlay and disappointing results?

I trust you will excuse me for speaking so plainly in this Institution. For nearly twenty years I have tried to get scientific principles introduced: nineteen years ago I published the necessary formulæ; very recently I have again brought the subject prominently forward before the Institution of Civil Engineers, when I was compelled to criticise rather severely the Woolwich practice.

In the Red Book it is stated that the Elswick practice, equally with their own, disregards formula, and this was also asserted by Sir H. Lefroy during the discussion, but it was denied by Captain Noble, who however added that "the calculated shrinkages were greatly modified "by the results of a long series of experiments carried on during "many years, chiefly by Sir W. Armstrong personally. Rightly or "wrongly proof had, it was believed, been obtained that with the "shrinkages applied, greater strength was got than would be the case

[1] Page 29.

" were the guns made in accordance with the rules recommended by " the Author" (myself).

With all due deference to Captain Noble, I must formally demur to his statement as being contrary to all correct reasoning.

If the experiments alluded to are of any value they are the expression of some law which is capable of embodiment in the formula, and the present formula must be erroneous or incomplete. I do not say it is not so, but I cannot take it to be so simply on the assertion of any one who fails to point out the error or the incompleteness, neither can I accept as proof, the opinion said to be arrived at, that the Elswick guns are stronger than guns made by my formula until I am shown that such has been the actual result of practice.

Let a gun be made by my formula, and another by the Elswick system, modified as it is by Sir W. Armstrong's long experience, and if the latter prove the stronger, I will admit, not that formulæ are of no value but that my formulæ are incomplete and require modification.

I have detained you thus long over this general statement because I feel so very strongly its importance, and I will now proceed to explain what are the necessary conditions for building up a strong gun and how the proper proportions may be arrived at.

The full details I have already given elsewhere.

Now the first problem is, as I said above, to determine the strains in a homogeneous cylinder subjected to external and internal pressures.

The following is the formula:—

t = tensions at any radius y.
R = external Radius.
ρ = internal Radius.
y any intermediate Radius.
f_0 = internal pressure.
f_1 = external pressure.

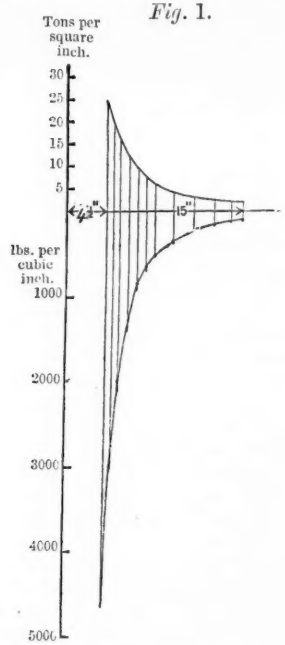
$$t = \frac{f_0 \rho^2 (R^2 + y^2) - f_1 R^2 (\rho^2 + y^2)}{y^2 (R^2 - \rho^2)} \qquad (1)$$

In this cylinder if we make $f_1 = 0$ we get the case of a solid homogeneous gun and the equation becomes

$$t = \frac{f_0 \rho^2 (R^2 + y^2)}{y^2 (R^2 - \rho_2)} \qquad (2)$$

The curve, fig. 1, represents the tensions of a 9-inch homogeneous gun 15 inches thick under an internal actual pressure of 24 tons per square inch.

Fig. 1.



From this it is apparent how great is the waste of material in such a structure, for whilst it is strained at the inside to 26·70 tons per square inch, the strain at the outside is only 2·63, about 1-10th, and yet the quantity of material used at the outside is vastly more in proportion to the strain.

This is well shown in the curved line below the line of abscissæ which represents the ratio of the strain to each cubic inch of material from the inside to the outside circumference.

Here we see that whilst there is one cubic inch of material for 4,233 lbs. of strain at the inner surface, there is one cubic inch for 96 lbs. at the outer surface, so in other words the ratio of strain to weight varies as 44 to 1 between the inner and outer portions of the gun.

If there be any who advocate the use of solid steel guns they would do well to reflect that whilst they are providing a strong and costly metal to resist the initial strain which may be represented by 4,233 lbs. per cubic inch, they are employing the very same costly material where the strain will not exceed $\frac{1}{44}$th of that amount.

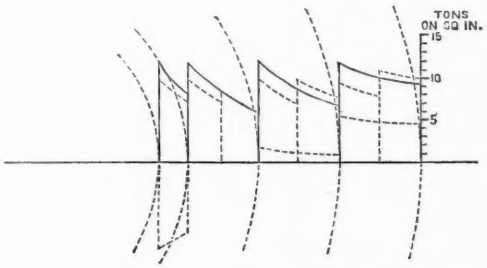
I now proceed to the case of built-up guns.

Here we have a series of concentric cylinders shrunk one over the other so as to distribute the strains more equally.

By the formula which I have given elsewhere the various strains are

calculated and the following diagram, Fig. 2, shows the case of a gun built up of an inner tube and three concentric rings so proportioned that the maximum strain in each ring is the same throughout.

Fig. 2.



If then this maximum be within the limit of elasticity of the material it is evident that this gun will never fail.

But if the dimensions of the rings be not calculated by the proper formula so that the shrinkages be suitable to the modulus of elasticity, a very different state of affairs would exist.

In this case one or more of the rings may be strained beyond its elastic limit, a permanent set may take place, each successive firing may increase the derangement of the strains, and finally by increasing the strain in the inner tube it may give way by cracking.

This has been the fate of many of the Woolwich guns and amongst others the celebrated 81-ton gun, regarding which I will read the following extracts from official documents.

In Minute 34636 16/3/77 the Superintendent of Royal Gun Factories reports "that on examination of the experinental 80-ton gun, "it was found that the steel tube was cracked . . . widest at "70 inches from bottom of bore . . . extending about 15 inches "along the crown in both directions."

Two months afterwards the Director of Artillery forwarded the foregoing report to the Secretary of State for War, remarking, "that the "crack is unfortunate, but shows the great strength of the structure." "Although the tube cracked, the gun itself has not given at all," as if the tube was not a part, and *the most essential part*, of the gun.

He continues: "Valuable information has been obtained, and the gun "has shown great strength and endurance."

I certainly cannot agree with this gentleman that the crack shows the great strength of the structure, or that although the crack increased, the gun itself showed no signs of damage, or that the gun has shown great strength and endurance; but possibly he himself modified his opinions when he stated afterwards that "a third crack was "discovered, and he thinks the gun is slowly breaking up."

The strength of a built-up gun, if properly designed, increases as the

number of concentric rings increases, thus if six rings were used instead of three the diagram of strains would be approaching to Fig. 2, upper dotted lines, and if the system of wire were adopted it would be practically a straight line at the top.

The cost of construction increases very considerably with the number of rings, as does the probability of error from imperfect workmanship, whilst with wire there is no extra cost of construction, and no accuracy of workmanship is required as the initial strains are not the result of shrinkage but are actually measured as the iron is coiled on.

Moreover steel in the form of wire is much stronger than in large masses, and the extra cost per ton of the wire would be much more than compensated by the lesser weight of material and the greater facility of its application.

In a gun of many concentric coils, and especially in a wire gun, we can so adjust the initial strains that the tension on the inner tube during explosion may be reduced *ad libitum*, and indeed it may remain always under compression.

I believe therefore that chilled cast iron might be used for the inner tube and the rifling cast in it and afterwards ground out by an emery lap.

The Elswick guns are certainly stronger than the Woolwich guns, because the rings are more numerous and more carefully adjusted. The same may be said of Sir Joseph Whitworth's gun were the successive coils laid on with proper shrinkage.

In his 38-ton gun Sir Joseph has four coils over the tube at the powder chamber against two in the Woolwich, and assuming that these coils are correctly proportioned the strains with an internal pressure of 24 tons per square inch would be approximately represented by the diagram No. 3, whilst the strains on the Woolwich 38-ton gun are represented by figure 3*a*.

Fig. 3.

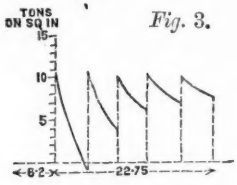
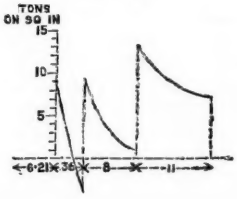


Fig. 3*a*.



The maximum strains would be as follows :—

Woolwich gun, steel tube	7·92	tons.
„ 1st iron coil	9·38	„
„ 2nd „ „	13·74	„
Whitworth steel throughout	10·00	„

It is therefore evident that the Woolwich gun with a very inferior material outside the tube is strained in the second coil beyond the elastic limit and permanent set would take place.

I have probably said enough to convince you that the Woolwich gun is of very faulty construction, and those who are interested in the question will find this fully demonstrated in my late paper on the construction of heavy ordnance.

I will therefore pass on to a few further general remarks.

The first is that the amount of shrinkage is not arbitrary. It depends upon the modulus of elasticity of the material and the number and dimensions of the rings and upon the maximum which may be fixed on for the working strains.

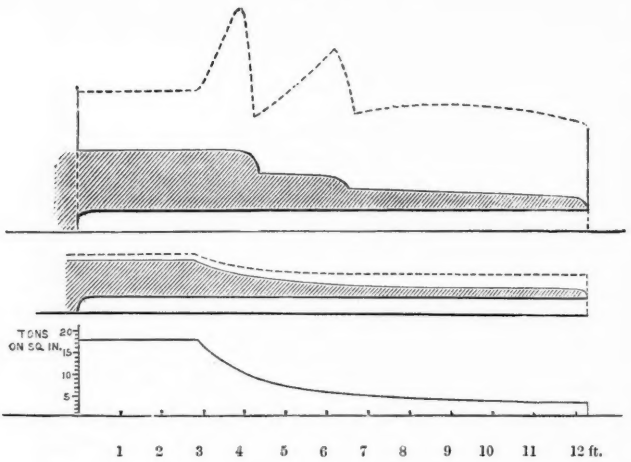
In the next place it is a great mistake to fix upon a uniform ratio between the thickness of the gun and the calibre, which is the practice at Woolwich as stated by General Younghusband in the late trial Thomas *v.* Queen.

It is also a great mistake to adopt few and thick rings of common iron instead of more numerous rings of steel, and this is also far from economical, because although the cost of the iron per ton be comparatively small *in its original state*, it becomes very expensive by the time it is in the finished guns.

The enormous extra weight of extraneous material on the Woolwich guns may be well illustrated by the following diagram, Fig. 4, which is thus constructed.

I take the 10-inch gun, the pressure curves of which with 70 lbs. charge pebble powder and 300 lb. shot are given in Captain Noble and Mr. Abel's valuable paper in the Phil. Trans. 1875.

Fig. 4.



The lower figure represents the pressures.

The upper one represents the thickness of the 10-inch Woolwich gun, and the middle one the thickness of a perfect gun uniformly strained to 10 tons per square inch, with the internal pressures of the diagram.

The dotted lines in each figure represent the ratio of cubic inches of material to internal pressure, showing the enormous disproportion and irregularity in the Woolwich gun.

If such a gun as is represented by the middle figure were made, it would evidently be very much lighter than the other, and the extra weight required on account of the recoil might be a simple cast iron casing, inside of which the other would be placed, and which would cost perhaps £7 or £8 per ton instead of the £80 or £90 per ton of the Woolwich gun.

Before leaving the question of construction I must make a few further remarks about shrinkage, regarding which I cannot but think there still exists a good deal of misconception.

For instance, it seems to be thought by some that when the gun is at rest all the tension of the outer rings must be supported by the inner tube and therefore that the amount of possible tension is limited by the compression which the thin inner tube will bear.

This is altogether erroneous, because the compression is not borne solely by the inner tube, and by properly proportioning the thickness and shrinkages of the rings we can distribute the compression pretty much *ad libitum*.

Again, I find it stated by Major Morgan in the paper which he read here on "Breech Loading and Muzzle Loading for Guns," "that the

"utmost possible strength that can be obtained by shrinkage is to "*double the strength which would be given by the same material without shrinkage.*"[1]

I must entirely dissent from such a statement, and without going into calculations in this place, I will point to the drawing, Fig. 9, which shows the strength of a gun 12 inches bore and $22\frac{3}{4}$ inches thick, built of a material the elastic limit of which is 10 tons per square inch. The full lines represent the strains under firing when the material is strained to 10 tons per square inch and when the five concentric rings are put on with a proper tension. In this state the gun will resist an internal pressure of 24 tons per square inch.

Now the strains in a gun of the same material and same dimensions but without shrinkage (which is what I call a homogeneous gun) are represented by the dotted line, and it shows that the maximum strain is also 10 tons, but this gun will only resist an internal pressure of 4·871 tons per square inch.

In other words an internal pressure of 4·871 tons will strain the material as much in this gun as a pressure of 24 tons per square inch with others; so that the gun built up with shrinkage is quite five times as strong as the other.

A great deal of the discussion which has been so keenly carried on respecting the best material for the inner tube and the outer coils seems to me to have arisen from a want of appreciation of the effect of shrinkage duly applied.

Sir William Palliser advocates a soft yielding material for the inner tube, and he is right, for such moderate pressures as will not give the tube a permanent set, and when he has a heavy mass of cast iron outside.

He would be right also in applying such a tube to the Woolwich gun as at present constructed, or to any hooped gun constructed as it is without proper regard to initial tension. In such a case the yielding soft tube would gradually accommodate itself to its position and in doing so would vary and possibly to some extent equalize the discordant strains among the outer rings, and the tube would not crack as the steel tube of the Woolwich gun does, and the gun might last a very long time under severe trial, but none the less would it be (all but certainly) undergoing a gradual deterioration, and its fracture might come unawares and probably be attended with fatal consequences.

Sir William Armstrong on the other hand advocates a hard steel tube and yielding iron rings outside.

Here again if the rings are properly proportioned he may make a good gun. If they are never strained beyond the elastic limit and if the steel tube also is under the same conditions, then, it matters not how hard it is, the gun will never fail by bursting.

Nay, so far is it true that the nature of the material and its behaviour is regulated by the tensions, that a chilled cast iron inner tube bound round with steel wire or encased in steel rings

[1] *See* Journal. Vol. xviii, p. 408, *et seq.*

or even iron hoops properly proportioned, would make a perfectly safe gun.

Heating of Guns.

Before leaving the subject of construction I must advert to a question of great importance connected with all built-up guns, viz., the effect of heating of the gun upon the strains induced by the explosion.

Effect of Heating.

It is maintained by some eminent men that this heating is due to the actual transmission of heat from the powder gases to the interior surface of the gun and thence by conduction throughout its mass.

This I hold to be entirely erroneous. Very little heat is so transmitted and the greater part of the heat set up is due to the vibration of the molecules of the material set up by the sudden application of the force of the explosion.

As I had the misfortune to differ altogether from Dr. Siemens on this point during the late discussion at the Institution of Civil Engineers I wrote to Professor Tyndall asking his opinion. In his reply he did not give any opinion of his own but informed me that Count Rumford had made a special investigation on the subject and that his conclusions agreed with mine. I have since referred to Rumford's paper, which is not in the old Edition of his Works but is contained in the new Edition published in 1876 by the American Scientific Society.

His experiments are very interesting and conclusive, but there is one thing which at first sight seems to militate against the theory, and that is that the heating effect is greater when the charge is fired without a shot and even without a wad. This however is really confirmatory of the theory.

1st, Because under these circumstances the temperature of the gases thus being uncompressed, is lower.

2nd, Because the rapidity of their escape being greater, the time of contact is less.

The real reason of the increase of heating is that the velocity of the impact is enormously increased although its statical intensity is very much less.

A pressure of 100 tons per square inch applied very gradually, say in 10 seconds of time, would set up very little heat, but a pressure of 1 ton applied at a velocity of 6,000 or 7,000 feet per second would generate a great deal, and thus it is that the lower pressure of the unconfined powder gases acting with the enormously increased velocity, sets up more heat than the higher pressure guns when confined by a wad and heavy shot in front of it.

Rumford's experiments therefore entirely confirm my own view.

But I can carry the matter further and show that independent of experiment we may conclude that it must be so.

Heat can only pass from one medium to another at a certain rate,

that is to say, only a certain number of units of heat can enter a square foot of steel or iron in a second of time. This number of units depends *firstly* upon the nature of the material. It is different in lead or copper from what it is in iron or steel.

It depends *secondly* upon the state of the absorbing surfaces. According to Professor Tyndall the rate of absorption is equal to the rate of radiation, and this is very much less in a polished surface than in a rough one.

3rd, It depends upon the difference of temperature of the media but not directly on the difference except when these differences are very small.

According to Dulong's experiments the loss due to radiation is

$$R = m\,a\,t^{1}\,(a^{t}-1)$$

when R=loss of heat per square metre in French units per hour.

t^{1}=temperature of the recipient medium.

t=excess of temperature of body over that of the medium.

a=a constant=1·0077.

m=a constant depending on the nature and surface of the emitting body and found by Peclet to be=124·72 K.

A table of the values of K is given by Peclet and is as follows for such materials as are used for guns:—

Polished iron..	0·45
Ordinary iron	2·77
Rusted iron	3·36
Cast iron, new	3·17
Cast iron, rusted	3·56

Now according to Noble and Abel the temperature of the gases during explosion is 2,231° C (or 4,015° Fah^{t}) and if we assume the temperature of the gun to be 31° C, we get,

t=2200° t^{1}=31° and for polished iron m=124·72×0·45=56·124.

therefore $R = 56{\cdot}124 \times 1{\cdot}0077^{31} \times (1{\cdot}0077^{2200} - 1) = \text{Log.} -^{1} 9{\cdot}181275$.

To reduce this to units per feet per second we must divide by 10·794 × 3600, which gives 3,906 French units per square foot per second, or 7,030 English units per square foot per second.

Now the time during which this heat would be applied would certainly be not more than ·002″ so that the heat transferred in this time would be 7030 × ·002=1·4 units of heat per square foot of surface.

Even assuming that the surface was not polished, but in such a state as to admit heat as rapidly as ordinary iron, the transmission of heat would not exceed six times the above, or 8·4 units of heat, and this at the breech end of a 12-inch gun would have to heat 4·74 cubic feet, or 2,275 lbs. of iron; and as the specific heat of iron is 0·113, 8·4 units would heat 74 lbs. of iron 1°, or 2,275 lbs. of iron about $\frac{1}{50}$ of a degree Fahrenheit.

Even if we suppose that the whole of this heat was instantaneously transmitted into the inner surface of the bore to a depth of not

exceeding $\frac{1}{4}$ of an inch, it would have to raise 31 lbs. of metal, and this it would only do to a temperature of 39°·57 Fahrenheit.

It is therefore evident the heating which is actually observed in guns cannot be due to the heat of the powder gases.

This may be further evidenced by the consideration of the law of transmission of heat through a solid body, supposing one of its surfaces to be maintained at a given constant temperature.

The equation of transmission is the following:—

$$T_1 = T \left\{ 1 - \frac{2}{\sqrt{\pi}} \int_o^{\phi} \epsilon^{-\phi^2} \, d\phi \right\}$$

$$\text{when } \phi = \frac{x}{2\sqrt{kt}}$$

T = Constant temperature at which the surface is maintained.
T_1 = temperature at x after a time t.
x = the distance from the surface.
t = the time which has elapsed.
$k = \frac{\text{conductivity of metal}}{\text{specific heat} \times \text{density}}$ $\left(\text{for iron } \frac{29}{\cdot 113 \times 7\cdot 72} = 33\right)$
1 metre is the unity of measures.
1 hour the unity of time.
1° Centigrade the unit of temperature.

and writing P for the value

of the integral $\frac{2}{\sqrt{\pi}} \int_o^{\frac{x}{2\sqrt{kt}}} \epsilon^{-\frac{x^2}{4kt}} \, d. \frac{x}{2\sqrt{kt}}$

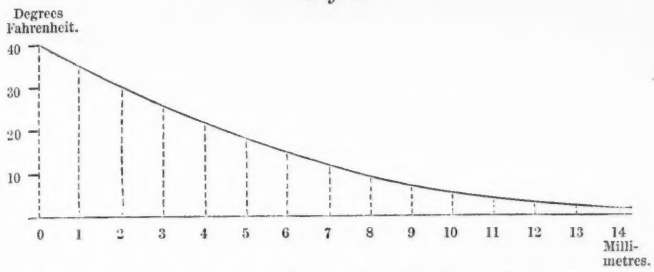
we get $T_{.1} = T \left\{ 1 - P \right\}_1$

and calculating the value of P for $\frac{1}{400}$th second, the time the pressure is exerted, we should find the following values if the constant temperature of the surface were 40° Fahrenheit.

Values of x in Millimetres.	Temperature at x Fahrenheit.
·000	40°·00
·001	35·48
·002	30·95
·003	26·30
·004	22·19
·006	15·01
·007	12·40
·008	9·48
·009	7·34
·010	5·58
·012	3·05
·014	1·54
·020	0.26

[1] The value of this integral is given in Cournot's "Exposition de la Theorie des "Chances." Paris, 1843.

Fig. 6.



The diagram No. 6 formed from this table shows the rapid decrease of heat from the surface, and that the rise of temperature at two centimetres of depth would be only $\frac{1}{4}$ degree Fahrenheit.

The result of the above investigations is in entire accordance with the opinion I have expressed, and which was expressed by Rumford many years ago.

That a considerable degree of heat is set up is, however, indisputable, but unfortunately, we do not know the law of its distribution, nor the degree of its intensity.

As, however, it is due to the sudden strains induced in the material, we may perhaps conclude that the rise of temperature at any part is proportionate to the induced strain.

In the next place, we may assume that the rise is instantaneous throughout the mass. It has been suggested that the strain must take time to travel through the mass of the gun, that in fact it is a wave passing from the interior to the exterior, and decreasing in intensity as it goes on, and that if the gun was thick enough, the interior might have returned to its normal state before the strain reached the outside, but in the thickness we have to deal with in guns, such a consideration may be neglected.

The velocity of transmission of the strain would be not less than 11,000 or 12,000 feet per second, so that as regards the time the pressure is inside the gun the period of transmission through two feet of material would be quite unimportant, and may be practically considered as instantaneous, or rather that the whole of the strains, and therefore the whole of the heat, is set up throughout the mass at one and the same time.

Now it may be shown from the formula, that if the whole of a built-up gun be heated by any given amount, say 100° Fahrenheit, the strains would remain unaltered, provided all the rings were properly proportioned, and this would also be the case in a gun built according to the formula, and especially so in a wire-built gun.

If, on the other hand, the rings be put on hap-hazard, or by rule of thumb, the increase of temperature may seriously affect the strains; and this is a new element of danger in the Woolwich guns and all others unscientifically put together.

I may further remark that inasmuch as the change of strains in the

material, and the attendant change of temperature is not uniform throughout, the alteration of condition in the structures will be of the more importance in guns when the change is *per saltem* than in those when it follows a uniform law, and hence it is that in guns consisting of many hoops (and especially in wire-built guns), the matter is much less important than in guns consisting of only two or three rings.

For instance, in the Woolwich 81-ton gun, the change of strains is as follows, under an initial pressure of 22 tons :—

	Tons.	
Steel tube, inner surface ..	27·31	increase by explosion.
,, outer ,, ..	12·51	,, ,,
1st iron ring, inner ,, ..	9·40	,, ,,
,, outer ,, ..	4·24	,, ,,
2nd iron ring, inner ,, ..	3·67	,, ,,
,, outer ,, ..	2·07	,, ,,

and if we assume the rise of temperature to be 5° Fahrenheit for each ton of strain, and the expanse of the metal tube to be ·000007 of the length for 1°, we would have the following expansions in each case :—

Steel tube	Inner surface	·000956 *l.*
	Outer surface	·000438 *l.*
1st iron tube	Inner surface	·000330 *l.*
	Outer surface	·000145 *l.*
2nd iron tube	Inner surface	·000128 *l.*
	Outer surface	·000073 *l.*

and the original and increased radii would be :—

		Original.	Increased.	Increase.
Steel tube	Inner surface	16	16·0153	·0153
	Outer surface	24	24·0105	·0105
1st iron tube	Inner surface	24	24·0079	·0079
	Outer surface	45	45·0065	·0065
2nd iron tube	Inner surface	45	45·0075	·0057
	Outer surface	72	72·0053	·0053

These differences would entirely alter the subsequent strains, being equivalent to very considerable increase in the shrinkage.

Now in the gun of many coils, these alterations would be very much less, and in the wire-gun, they would follow a uniform law which might easily be allowed for in the original construction, so that by firing a charge without a shot, the gun would at once be brought up to its maximum state of strength, or very nearly so, and subsequent firing would make little or no difference.

The effect of heating, therefore, may be fully provided against in a gun built according to formula, but might have very serious consequences in one built up hap-hazard.

Having thus laid down the general principles of construction, I will briefly refer to one or two systems of gun making in illustration.

I regret that I am not able to say anything beyond what I have already said with respect to Sir William Armstrong's system, owing to my not having received in time the information which Captain Noble kindly has sent me as to the dimensions and shrinkages employed at Elswick.

I must therefore confine my remarks to Sir Joseph Whitworth's and Sir William Palliser's guns, and I begin with Sir Joseph Whitworth's.

Sir Joseph Whitworth's Gun.

Formerly Sir Joseph used to build up his guns of concentric rings or hoops, made slightly taper and forced one on the other by hydraulic pressure.

By the extreme accuracy of workmanship for which Sir Joseph's establishment has so long been justly famed, there can be no doubt that if the calculations are correctly made, a very excellent gun could be made in this way, though of course it would be costly; but Sir Joseph has such perfect confidence in his compressed steel that he does not now deem it necessary to avail himself of the additional strength which would be obtained by putting the successive hoops on under shrinkage, so that in fact his present gun, although built up of successive rings for the sake of convenience, is in the same condition relative to internal strains as would be a solid gun of the same dimensions and materials.

Admiring, as I do, Sir Joseph's material, I think he is not giving either it or himself fair play in thus abandoning the true principle of coil construction.

I have prepared three diagrams, Nos. 7, 8, 9, showing the resulting strains with an internal powder pressure of 24 tons per square inch in Sir Joseph's 12-inch gun, first (Fig. 7), as it is now built without initial tension, secondly (Fig. 8), as it would be if the coils were all put in with an initial strain of $\frac{1}{1000}$th (the Woolwich practice), and third (Fig. 9), if with the same dimensions of rings the initial shrinkage were properly calculated and worked to.

Fig. 7.

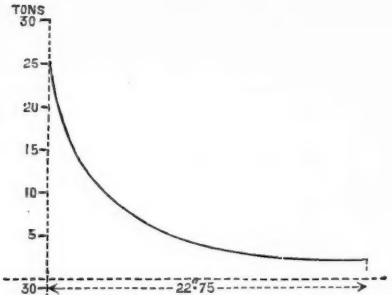


Fig. 8.

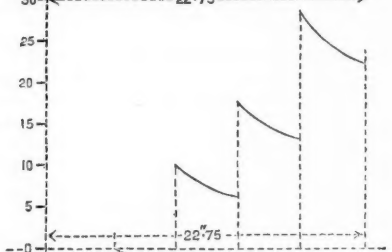
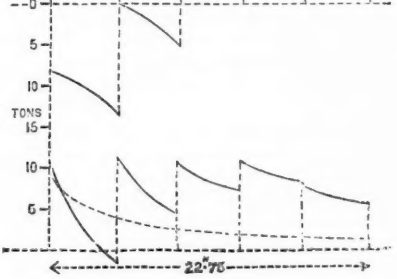


Fig. 9.



These diagrams illustrate very forcibly the vast importance of properly regulated shrinkings.

In the first, where there is no shrinkage, the strains vary from 28·18 tons at the inside to 2·30 tons at the outside.

In the next place with a uniform shrinkage of $\frac{1}{1000}$th (the Woolwich practice), the strains are from $7\frac{1}{2}$ tons compression to $27\frac{2}{3}$ tons tension at the inside of the outer ring. The inner tube and the first ring being never out of compression, the second tube doing very little work, whilst the outer tube is greatly strained.

Sir Joseph informs me that his compressed steel has an elastic limit of 30 tons per square inch. If so, the gun would be safe under either of the foregoing conditions, although very close to the boundary between elasticity and permanent set.

In the third case, however, no portion of the gun is strained beyond 10 tons per square inch, and each tube is strained exactly to that amount at its inner surface except the outside one of all, which is only strained to 7 tons.

This gun would be absolutely safe even for much higher pressures than 24 tons per square inch, and might be fired until absolutely worn out without fear of bursting.

I hope then that Sir Joseph Whitworth will reconsider the matter and give his magnificent material a fair chance, by so arranging it as to permit of its all doing full duty.

I think, however, that he over-estimates the elastic limit of his compressed steel in stating it to be 30 tons per square inch.

In the American Ordnance Report for 1879, it is stated to vary from 15 to 18 tons, but as nothing is said about its condition as regards tempering, it is quite possible that by some peculiar treatment Sir Joseph may have been able to extend the elastic limit, although I very much doubt it reaching 30 tons.

I therefore strongly deprecate his abandonment of the advantages of shrinkage, and if he still persists in this course, would strongly advise him to follow Sir William Palliser in making the inner tube either of iron or of a very ductile mild steel.

I now come to Sir William Palliser's system of construction, which, without a doubt, has been of much advantage to the country in affording the means of utilising a great number of old cast-iron guns, and converting them into very efficient rifled weapons.

It is stated by Captain E. Palliser that not a single burst has taken place either in England or in the United States, out of nearly 2,000 service guns, from 64-pounders to the 40-ton gun.

I am indebted to Captain E. Palliser for a copy of his report on Sir William Palliser's system as applied in the United States.

In this report it is said that "the law laid down by Sir W. Palliser is this: '*Every gun must have a casing, and this should never be in a state* "'*of tension, but of repose, in fact of perfect rest, till called on to do its* "'*work each time the gun is fired.*'"

He goes on to describe the construction as an inner tube of coiled wrought iron pushed into an outer casing of cast iron by hand and secured by a ring screwed in at the muzzle; he says, "when the gun is "fired the tubes expand till they rest against the interior surface of "the casing, and then a sort of give-and-take work is set up between "the barrels and the great mass of the casing," and he adds, "this "construction gives enormous strength, a strength which has never yet "been carefully considered and estimated."

Now I confess I cannot quite follow this; does it mean that the give-and-take work between the tube and the casing is only a temporary action during the moment of explosion, and that the gun then returns to its normal state of no strain between the tube and casing? It would appear so from the first paragraph I quoted, where he says, "the casing "should never be in a state of tension, but of repose, in fact of perfect "rest, till called upon to do its work each time the gun is fired."

If this really be the meaning I must certainly demur to it.

The explosion must throw a strain upon the wrought-iron tube far beyond its elastic limit, but the tube being of soft and yielding nature stretches and takes a permanent set. At the same time the strain passes in part to the cast iron, and if it brings on a strain beyond its elastic limit, this also acquires a permanent set, and the condition described by Captain E. Palliser is only possible in case the two permanent sets should be exactly balanced. But even in this case this permanent set would go on increasing each time the gun was fired, and the gradual result would be to increase the strain upon the cast iron and decrease that on the wrought iron until at length the normal condition of the gun would be that of a soft iron tube compressed by a cast iron jacket.

If, now, this can be so arranged that the strain upon the cast iron never exceeds its elastic limit, the gun will have arrived at a permanent condition, and no amount of firing will alter it; but I do not believe this can be attained with cast iron in large guns and with heavy pressures.

The process of alteration of condition in these guns up to the sizes of which proof has been made, as recorded in Captain E. Palliser's report, and under the moderate powder pressure therein mentioned, viz., 9 to 13½ tons per square inch, will no doubt be very slow, but in large guns and with heavier pressure powder it would undoubtedly be more rapid.

There is a foot-note in Captain E. Palliser's report, according to which Captain Jeffers, Director of Ordnance, United States Navy, says: "that a 20-lb. charge of powder and 180-lb. shot does not "set "out" the iron tube against the casing.

If this be so (and it is quite possible), it is because the permanent set of the cast iron is equal to or exceeds that of the wrought-iron tube.

It is quite possible that this might be so for a few rounds, and that the tube would become slacker instead of tighter at first, but I am not in possession of sufficient information as to the permanent set of cast iron to enable me to determine this point by calculation.

That Sir William Palliser's system is one of very great value cannot be denied, and probably for guns of moderate size it would beat all others in cheapness, and equal them in durability, and to those to whom actual experience outweighs *d priori* reasoning, the fact that an old 32-lb. cast-iron gun converted into a 64-pounder by Sir William Palliser, fired 2,180 rounds with heavy charges, and is still a good serviceable gun, must be a convincing proof of the eminent services which Sir William Palliser has rendered to his country by his untiring perseverance in the face of many and great difficulties.

But when I come to consider the question of heavy guns, such as 9-inch and upwards, I must be guided by a careful study of the induced strains.

I will direct your attention to the 9-inch gun No. 3, mentioned in the American Ordnance Report for 1876, converted from a Rodman according to Sir William Palliser's system.

I find that with a charge of 20 lbs. of powder and 180 lbs. shot, the powder pressure was 9·3 per square inch.

The shrinkage between the inner tube and wrought-iron jacket was ·003 inches in the diameter, equal to about 1 in 100.

The slack between the wrought-iron jacket and the cast iron was 0·0055 inch or about 1 in 122 parts.

Under these circumstances the resulting strains would be as follows:—

Iron tube	Inner surface	19·67	Tons per square inch.
	Outer surface	14·45	" " "
Iron jacket	Inner surface	18·17	" " "
	Outer surface	14·78	" " "
Cast iron	Inner surface	0·9823	" " "
	Outer surface	0·2953	" " "

Now the elastic limit of this iron is given at 11·15 tons. Consequently the inner tube and jacket are strained from $3\frac{1}{2}$ to $8\frac{1}{2}$ tons above this limit, and a permanent set would result.

The permanent set of the same iron under a strain of $14\frac{1}{4}$ tons is also given as ·01 per inch of its length.

If then there were no outer shell of cast iron, the external radius of the iron jacket would become $6{\cdot}7425 \times (1 + {\cdot}01) = 6{\cdot}8101775$, but the inner radius of the cast iron was only 6·7482500, therefore the new condition of the cast iron in permanent set would be equivalent to a shrinkage of ·0619275 between the wrought iron and the cast iron, or about 1 in 110 parts.

From this it is evident that the wrought iron must be greatly compressed by the cast iron after the first round, and that the statement in the foot-note at page 3 of Captain E. Palliser's Report cannot be accepted as representing a general fact, although it might be true under particular circumstances.

Assuming, however, for the moment, that the effect of the first firing was simply to expand the iron so as to bring it in contact with the cast iron, I have again calculated the resulting strains from the same internal pressure of 9·3 tons.

They are as follows:—

Iron tube	Inner surface	14·16	Tons per square inch.
	Outer surface	9·85	" " "
Jacket	Inner surface	13·40	" " "
	Outer surface	10·56	" " "
Cast iron	Inner surface	3·24	" " "
	Outer surface	0·99	" " "

and comparing them with the previous strains we find—

		1st Fire.	2nd Fire.
		Tons per square inch.	Tons per square inch.
Iron tube	Inner surface	19·67	14·16
	Outer surface	14·45	9·85
Iron jacket	Inner surface	18·17	13·40
	Outer surface	14·78	10·56
Cast iron	Inner surface	0·9823	3·24
	Outer surface	0·2963	0·99

Thus showing a decrease in the strains on the wrought iron and an increase in those of the cast iron, and the same result would be seen as the number of rounds increased. Diagram Fig. 10, shows the state of this gun after the first and second round.

Fig. 10.

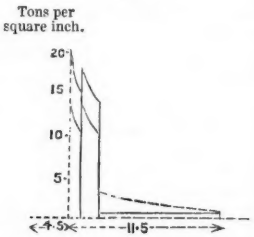
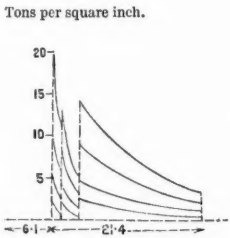


Fig. 10*a*.



The result of long-continued firing would thus be to throw a gradually increasing strain on the cast iron, and when that reached its tensile strength the gun would begin to crack from the inside; but inasmuch as the soft lining would prevent the penetration of the powder pressure into the crack, the crack would go on very gradually increasing, and would at last reach the outside and the gun would burst, but not with that explosive violence which it would have done but for the operation of the soft internal lining of wrought iron.

The gun would be a cheap gun, a safe gun, and a long-enduring gun, but there I must stop. It would in time fail, but probably the time would be long and the failure not attended with much danger.

But when we come to large guns and heavy powder pressures, I do not think we could trust to this system. We want a gun which will not burst at all, and which will last practically for ever, and for that I am convinced the future lies with the gun either made of Sir Joseph Whitworth's material in five or six concentric rings properly proportioned, or, better still in my opinion, in the wire-coiled gun which I have so long advocated, and which, as far as it has been tried, has given the most satisfactory results.

The diagram No. 10*a* represents the strains on Sir William Palliser's 12½-inch gun as described in the American Ordnance Reports, using the constants therein given.

The curved successive lines represent the tensions:—

	Bottom curve.	Second.	Third.	Top.
Charge ..	50 lbs.	80 lbs.	115 lbs.	—
Shot ..	580 lbs.	600 lbs.	700 lbs.	—
Powder pressure	4·46 tons.	9·15 tons.	15 tons.	24 tons.
Tensions:				
Iron tube—				
Inner surface ..	2·30 „	5·54 „	9·61 „	17·40 „
Outer surface ..	1·18 „	3·07 „	5·49 „	10·44 „
Iron jacket—				
Inner surface ..	2·243 „	4·50 „	7·44 „	11·50 „
Outer surface ..	1·011 „	2·07 „	3·30 „	5·18 „
Cast iron—				
Inner surface ..	2·746 „	5·484 „	8·91 „	14·01 „
Outer surface ..	0·647 „	1·272 „	2·10 „	3·30 „

Now the elastic limits of the material are given as follows:—

Wrought iron .. .. 9·5 tons.
Cast iron .. .. .. 4·33 „

Consequently with 80 lbs. powder, and 9·15 tons internal powder-pressures, the wrought iron is below its elastic limit, but the cast iron 1·15 tons above. With 115 lbs. powder, and 15 tons internal pressure, the wrought iron of the inner tube just reaches its elastic limit, whilst the cast iron is 4·56 tons above, and with 24 tons internal pressure,

The inner tube is strained 7·90 tons above,
The jacket „ „ 2·00 „ „
Cast iron „ „ 9·50 „ „

And it is clear that for all pressures exceeding 10 tons per square inch, permanent deformation would take place, very slowly at first, but increasing more rapidly as the pressures increase.

Rifling.—The next question to which I wish to direct your attention is that of Rifling.

In the Woolwich Treatise of 1877, page 41, the object of rifling is stated to be "to give the necessary amount of rotation with a minimum pressure on the grooves, or in the studs, ribs, or soft coating, of the projectile itself, by the most simple means and with the least possible loss of power." That is to say the desiderata are—

1st. Minimum pressure on grooves and studs.
2nd. Simplicity.
3rd. Minimum loss of power.

There are two very distinct systems of rifling, viz.: that with a uniform and that with an increasing twist.

The latter is that which is adopted at Woolwich, and I believe also by Sir William Armstrong.

Let me examine how far it meets the desiderata above named.

The Woolwich groove is a spiral of a parabolic form in develop-

ment, beginning with one turn in 100 calibres and ending at the muzzle with 1 in 40.

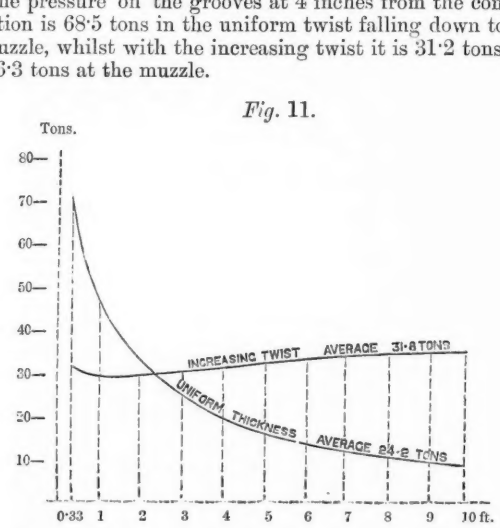
If this be compared with a uniform twist of 1 turn in 40 calibres, it is obvious that the ultimate velocity of rotation is the same with the same muzzle velocity.

The first point then to be considered is the pressure between the grooves and the studs or ribs of the projectile, and it is here that the first mistake has been made at Woolwich.

Captain Noble has given formulæ (Phil. Magazine, March 1873), from which tables have been calculated which are given in the Woolwich Treatise on Construction, pp. 44 and 45, showing the total pressure on the studs in a 10-in. gun fired with 85 lbs. pebble powder and 400 lbs. shot, the first table being for a uniform twist of 1 in 40, and the second an increasing twist of 1 in 100 to 1 in 40 at the muzzle.

From this table, from which diagram Fig. 11 is made, it appears that the pressure on the grooves at 4 inches from the commencement of motion is 68·5 tons in the uniform twist falling down to 9·1 tons at the muzzle, whilst with the increasing twist it is 31·2 tons at 4 inches and 36·3 tons at the muzzle.

Fig. 11.



The argument which is drawn from this at Woolwich, is that this decrease of maximum pressure from 68 to 36 tons is a matter of much importance.

But it is not the absolute amount of pressure which is important, but the amount of pressure per square inch of surface against which it is exerted.

If the 36 tons has to be borne by 1 square inch of surface, and the 68 tons by 10 square inches, it is very evident that the strain on the material would be rather more than five times more with the lesser pressure than with the greater.

Again, were it absolutely necessary to limit the bearing surface, there would no doubt be an advantage in the increasing twist, but it is this very increasing twist which necessitates the limitation of the bearing surface.

In this system the rotation of a 12-inch Palliser shell is dependent on nine studs of copper hardened with tin, each giving a bearing surface which projected on the radius, would be about $\frac{1}{4}$-inch, so that if all the studs were bearing equally (a thing impossible in practice), the total bearing surface would be $2\frac{1}{4}$ square inches, giving a pressure of 16 tons per square inch in the increasing twist, and $30\frac{1}{2}$ tons per square inch in the uniform twist; but mark the difference—in the uniform twist there is no need to limit the studs to one row, four or five rows may be used, or better still, continuous ribs extending the full length of the cylindrical portion of the shell. Thus, each rib might have a bearing surface of 4·8 square inches, or the nine ribs 43 square inches, and the pressure per square inch would be reduced to $\frac{68}{43} = 1\frac{6}{10}$ tons per square inch.

It is therefore unquestionable that the strain on the material and consequently the wear and tear, would be greatly less in the uniform twist with an extended bearing surface than in the increasing twist with its necessary stud and projectile.

The next desideratum is simplicity. Here there can be no doubt that the uniform twist has the advantage. It is true that there is no practical difficulty in rifling a gun with an increasing twist when once the rifling machine is adapted to it, but there is more complication with studded projectiles than in those for the uniform twist where the ribs may be cast on at once, and are thenceforward free from all liability to injury.

The third desideratum mentioned in the Woolwich Treatise is the least possible loss of power.

Now the loss of power is not great in either system, but it is less in the uniform twist than in the increasing twist. Reverting to Captain Noble's tables for the 10-inch gun, it will be found that the average pressure in the uniform twist was 24·2 tons against 31·8 tons in the increasing twist, being a saving of 24 per cent. in favour of the uniform twist.

Consequently in each of the three specified particulars, the uniform has a decided advantage over the increasing twist.

But there are other questions involved of much greater importance.

The first and most serious of those is that of safety.

It is universally admitted that the strain on a rifled gun is greater than on a smooth-bore, and it is often supposed that such increased strain is due to the rifling.

This is altogether a mistake. There would be very little difference of strain in the smooth-bore and the rifled gun with shot of the same weight and where the twist was within any ordinary limit. The actual increase of pressure at the back of the shot caused by the resistance of the grooves is very slight in comparison with the total pressure, and so long as the shot moves freely in the grooves no danger can arise; but if by any means the onward motion of the shot be

suddenly arrested or rapidly decreased, enormous strains would be brought on to the chase of the gun.

There would first be the strain arising from the loss of energy which would be proportional to the square of the decrement of the velocity, and would tend to tear the gun asunder longitudinally, and there would be secondly the rapid increase of a wave pressure in the powder gases caused by a portion of their energy being absorbed in their own compression, and this strain would cause an internal pressure tending partly to tear the gun asunder, and partly to burst it radially.

The amount of these strains would depend upon the degree of suddenness with which the progress of the shot was arrested, and upon the velocity with which it was moving when the arrest took place.

If then there be any tendency to arrest the shot, which there is in all rifled guns, the result of such arrestment, *cæteris paribus*, will be as the square of the velocity of the shot.

In the next place it may be assumed that the tendency to arrestment will be proportional to the actual pressure on the groove of the rifling.

Consequently the co-efficient of danger will be as the pressure in the groove multiplied by the square of the velocity of the shot.

This being so let us compare the co-efficient of danger in the 10-inch gun as given in the following table:—

Distances the shot has travelled.	Co-efficient of danger, viz., pressure × velocity^2.		Ratio.	
	Uniform twist.	Increasing twist.	Uniform.	Increasing.
0·333	68·5 × 411^2	31·2 × 411^2	68·5	31·2
0·945	47·7 × 675^2	28·7 × 675^2	47·7	28·7
1·834	34·6 × 873^2	29·0 × 873^2	34·6	29·0
2·400	29·5 × 960^2	29·5 × 960^2	29·5	29·5
2·723	27·5 × 992^2	30·2 × 992^2	27·5	30·2
4·500	18·7 × 1146^2	32·3 × 1146^2	18·7	32·3
6·278	13·5 × 1245^2	33·8 × 1245^2	13·5	33·8
8·055	10·6 × 1311^2	35·2 × 1311^2	10·6	35·2
9·833	9·1 × 1349^2	36·3 × 1349^2	9·1	36·3

Thus it is seen that although the co-efficient of danger is 2·2 times as great at a distance of 4 inches from the beginning of motion in the case of the uniform twist as it is in the increasing twist, yet at the muzzle end it is four times less.

But this only represents the *liability to accident*, and it is further to be considered what would be the relative result of the accidents if they did occur, that is to say if the shot got jammed.

As regards the energy of the shot tending to tear asunder the chase it would be as follows:—

If stoppage took place at 0·333 = 486 foot tons.
" " " at 2·40 = 2556 "
" " " at muzzle = 4506

It is thus seen that in the uniform twist, although the tending to accident is about twice as great as in the increasing twist at the beginning of the motion, yet the actual result of a total stoppage at that point would be only measured by 468 foot tons, whilst with the increasing twist where the tendency to accident is four times greater than in the uniform twist the result would be 5,046 foot tons, or about $11\frac{1}{2}$ times greater than the other.

At a distance of 2·4 feet from the beginning of the motion, the tendency to accident and the result of accident would be the same in both systems, because the pressure on the grooves and the velocity are the same, but after that point, whilst the result of accident would be the same, the tendency to accident increases rapidly in the increasing twist, that is to say, that when the consequences of accident would be most disastrous, the tendency to accident is much the greatest with the increasing twist.

The above estimate refers to the case of a total stoppage of the shot such as must result from a jam, but the same reasoning applies to a retardation such as might be caused by a partial jam or squeeze of the studs in the grooves.

Supposing such retardation was equivalent to one-sixth of the total energy of the shot then at the distance of 2·4 feet from the commencement of the motion the energy destroyed by the partial jam would be 436 foot tons, and as that would be about equal to the resistance of the steel tube, such a retardation might take place without rupture, that is to say, that in all that part of the chase where the liability to accident was greatest in the *uniform twist*, the retardation would not destroy the tube, whilst in all the rest of the chase being over a length of 7·4 feet where the liability to accident was greatest in the increasing twist, the retardation would be fatal.

It is therefore clear that the tendency to accident is greatest in the increasing twist just where the consequences would be most disastrous.

But there is another tendency to accident peculiar to the increasing twist, viz., the necessity of the very limited bearing surface due to the rotation being given by studs.

It is of course impossible to have an extended bearing longitudinally with an increasing twist, as much so as it would be to insert a screw bolt in a nut of an increasing pitch, consequently the force to give rotation is actually borne by one row of studs.

Now in the 38-ton gun with a Palliser shell of 700 lbs. the force would amount to 63 tons, and if this were uniformly distributed over the nine driving studs there would be a pressure of about 35 tons per square inch of surface; but if, as is probable, the actual work is done by not more than six studs, the pressure per square inch would not be less than $52\frac{1}{2}$ tons per square inch.

Moreover, this is on the hypothesis that the force is acting normally to the surface of contact between the shell and the grooves. As, however, the driving surface of the groove is *not* radial to the bore, but at an average angle of about 45°, the force exerted on the surface would not be less than 73 tons per square inch on the surface of the

groove and on the stud. This is much in excess of the resisting power of gun-metal, and consequently the studs are crushed against the inner edge of the groove, and tend to spread between the surfaces of the shot and that of the steel tube and thus to jam the shot in its passage as well as to shear away the driving side of the groove. Under these circumstances it is not surprising to find the grooves are often injured, and any injury thus caused tends powerfully to increase the danger of jamming with each successive shot. In the 38-ton gun of the "Thunderer" it was stated by Gunnery Lieutenant Gibson that when the shot followed the rammer whilst the gun was in its loading position it did not *in this gun* come down to the muzzle but stopped at about 80 inches from the breech. It is very probable that at that point there was some injury to the grooves caused by previous firing, and as it was stated by the same witness that 49 rounds had been fired previous to the burst, since any examination of the bore had been made, it is evident that very considerable damage might exist in the grooves without the knowledge of those who were in charge of the gun.

The damage was no doubt seriously aggravated by the Palliser shell of the electric round preceding the burst, which although it did not actually wedge itself fast in the bore, yet met with such a resistance as to give rise to the abnormal concussion which was greater, as the Staff Commander remarked to Captain Chatfield, than he had ever known before. Then came the fatal round when the shell actually jammed hard and fast and destroyed the gun.

If this be so, if the inevitable tendency of this system of rifling led in the case of the "Thunderer's" gun to the disatrous accident of 2nd January last, what security is there that a like result may not at any time recur? There is none whatever. The probability is in fact that such accidents will recur, if indeed it be allowable to call an accident that which is the consequence of a tendency inherent in the system of rifling.

By constant watching and frequent examination of the bore of the gun the danger may no doubt be lessened, but the necessity of such constant watching is in itself sufficient to condemn the system.

Moreover such damage as is above referred to is in fact a disablement of the gun, since the necessary repairs cannot be done on board ship, nor indeed anywhere else than at Woolwich Arsenal.

The "Thunderer" carries as her armament four of such guns. Is that a suitable armament which may at any time be disabled, not by actual warfare, but by the inherent vice of the system of construction and during the ordinary drill-practice of the crew?

The question admits of only one reply, and even did the increasing twist possess, as it does not, practical advantages of its own, such would be quite out of the question in face of the enormous contingent danger attendant upon it and inherent in it.

I would have liked to have said something about accuracy of firing, as dependent on the system of rifling, but time does not permit my going further into the various details of rifling, and I will only say that to my mind a uniform twist and an extended bearing surface are the essential features to be kept in view.

I now call your attention briefly to

Chambering.

We have heard a good deal of late years of what is called "Chambering," as if it were a new and important improvement by virtue of which the power of our guns was to be largely increased.

Let us inquire a little into this. Chambering is simply boring out the gun at the breech end where the charge of powder lies to a larger diameter than the rest of the chase, and so it enables us to put a larger charge in a shorter length of gun.

Let us take for example the 38-ton 12-inch gun.

In this gun a battering charge of 110 lbs. powder occupies 27 inches of length out of 196 or $\frac{1}{7 \cdot \frac{1}{26}}$ of the length, therefore the number of expansion would be 7·26.

Now assume that this gun is chambered out to 14 inches, the length of the charge would be reduced in the proportion of 113 to 154, or from 27 to 20 inches.

Consequently the length of chase through which the powder acted would be 176 inches instead of as before 169 inches.

But the number of expansions of the powder gases would only be in the proportion of the volume of the charge of powder to that of the capacity of the gun before and after chambering, that is to say as $\frac{1}{7 \cdot \frac{1}{26}}$ to $\frac{1}{7 \cdot \frac{1}{53}}$ or equivalent to 7·26 expansions in the one case and 7·53 ditto in the others.

Consequently the economic effort as regards the powder would be very small, because the work done between 7·26 and 7·53 expansions is very insignificant.

On the other hand the result of chambering is to increase the length during which the powder acts upon the shot by 7 inches, that is to say from 169 inches to 176 inches.

Now this increase of velocity in these 7 inches would certainly be not more than about 7 or 8 feet per second, even if the pressure remained constant, so that practically it will not be far from the truth if we take the increased velocity of the shot as about $\frac{1}{2}$ per cent., and I am therefore of opinion that there is scarcely any advantage in chambering, whilst it, no doubt, considerably weakens the gun.

It is a poor and inefficient expedient for lengthening a gun at the cost of its durability, and as such meets no favour in my eyes.

No doubt our guns are too short and especially for our slow burning powder.

Our slow burning powder is an expedient to meet the weakness of our guns. It drives us to adopt larger charges occupying more space in the gun and consequently diminishing the number of expansions.

The length of our guns is limited by the limited space in which they have to be worked and thus it is that we have much lower muzzle velocities than we might have and than are, as I am told, obtained by other nations.

Breech-loading.

I now come to the last division of my subject—that of breech-loading.

I do not pretend to enter upon the question of the relative facility of working breech-loaders as compared with muzzle-loaders, either as regards convenience, safety, or speed.

These are questions which regard those who have to use the guns, and it would be impertinent in me to occupy your time with mere opinions on a subject that I know practically nothing about; but assuming that the breech-loader is, as I believe it to be, the proper form of gun for heavy artillery and especially for ship use, I will very briefly point out the principle on which it should be constructed.

What underlies this principle is another, which may be thus expressed:—

No material should be subjected at the same time to two strains in directions at right angles to each other, if either of the two approach the limits of its elasticity.

Thus the chase of a gun, which is very heavily strained circumferentially, should not at the same time be called on to resist a longitudinal strain of any magnitude.

Yet this is exactly what happens in almost every gun whether muzzle or breech-loader.

It is argued, or rather I should say asserted, that there is always ample strength to resist the longitudinal strain caused by the recoil.

Taking the simple case of an 8-inch cast-iron gun, of which the walls are 8 inches thick at the breech, it is said that with an internal pressure of 20 tons per square inch we have a total force of 1,000 tons to transmit to the trunnions, and that we have to do this through a cross sectional area of 402 square inches, and that consequently there is only a strain of about $2\frac{1}{2}$ tons per square inch, which is quite a safe strain for cast iron.

But this is altogether as much wrong as it would be to assume that in a cast-iron cylinder every portion was equally strained by an internal pressure.

The inner part of the chase bears the greatest strain in resisting the blowing out of the breech. Again the strain from the trunnions is greatest at the outer circumference of the gun.

It is not possible to submit these strains to analysis, complicated as they would be with the varying circumferential strains, but it may safely be affirmed that the old-fashioned idea about sufficient longitudinal strength has no foundation, and that the safest way in constructing a gun is to avoid if possible all complex strains and especially those which cannot be exactly analysed.

Sir William Palliser pointed out what I have just been saying, very forcibly, before the Ordnance Select Committee in December 1867, and it was his knowledge on this subject which led him with his usual sagacity to the invention of that system of breech which has since been adopted with perfect success at Woolwich and elsewhere.

As a general principle, therefore, I maintain what I said nearly 20 years ago that the material for transmitting the force of the recoil to the gun carriage through the trunnions should be independent of the material of the chase. The one should resist the circumferential strain, the other the longitudinal, and any other material beyond this should be mere dead weight, such as ordinary cast iron, which would perform the same function through its inertia as cast steel costing twenty times as much per ton.

This principle gives special facility for the construction of large breech-loading guns. According to it you can calculate your strain with absolute accuracy, you can proportion your parts so that your material is never unduly strained, you can avoid all occult cross strains which baffle calculations, and you can thus build up a gun of any size with full confidence that it will do its duty.

In my paper recently read at the Institution of Civil Engineers, I described a system of construction for breech-loading and exhibited a small gun which had proved perfectly successful, and I believe the principle has been experimentally tried with success on a much larger scale in America.

Be this as it may, I have no hesitation in saying that the system is theoretically right and that it would prove the most efficient as well as the most economical of any that have come under my notice.

It is in principle the same as the system advocated by Major Morgan and which he has, I believe, already described in this Institution.[1]

Whether his mode of carrying it out, or my own, be the most practicable and convenient, experiment on the large scale must determine; but however this may be, I agree perfectly with that Officer in his opinion that the chase of the gun should be relieved altogether from longitudinal strain, and that only by the adoption of this principle can a perfectly safe breech-loader of large size be made.

I must now draw to a close. I have endeavoured throughout to call your attention to principles rather than to detail of construction, and I shall be glad if, in any discussion that may ensue, principles may obtain that prominence which their importance demands.

MAJOR J. P. MORGAN, R.A., C.M.G.: I have listened with great pleasure to the remarks from the eminent lecturer, and especially I feel highly grateful to him for his generous criticism of my gun. All along, I believe we have been travelling in the same line and are led by the same principles: and therefore, if I disagree with some of his conclusions, it is only that we may both advocate the true principles of gun making. He has been rather severe upon the Woolwich system, and if he had spoken as a practical manufacturer, I should have listened with very great attention to his observations, but I have seen the practical manufacture of guns, both in the Gun Factories and at Sir William Armstrong's, and I know the difficulties that exist with regard to shrinkage. I have known officers from Foreign Governments who have been superintending the manufacture of guns for their Governments, and had one simple means of determining if the guns had the proper shrinkage, and that was if the bore had been compressed after putting the coil on. This may appear very unscientific, but in practice it is found to answer very well, and the reason is, that the metals are not solid, but have a certain amount of air space, and when you put

[1] *See* Journal, vol. xiv, p. 479, *et seq.*

on the shrinkage, a considerable amount of this shrinkage will be absorbed by the fibre of the gun, and it is only if we can obtain a better material, such as Sir Joseph Whitworth's steel, that we can reason theoretically. Until then we must be content to adopt a rule of thumb in the matter of shrinkage, which, however, is only for the past. For the future, I believe Mr. Longridge is very able to assist us in the manufacture of guns. I have studied his last paper with regard to shrinkage, and I very much regret to say I do not agree with his formula. I think the reason is this. He reasons on both an extension and a compression which are added on to each other. For instance, if you put a bar of metal under extension, it extends to a certain amount, and it is argued if you also put it under compression, it also stretches it to a certain amount, and these it appears to me are added together as if the amount of elastic stretch could be doubled. Now with a bar of iron it is quite possible for both the tensions to take place, but a gun cannot certainly extend more than its mathematical figure. The surface cannot buckle, it cannot do more than maintain the same section of gun throughout; and if you admit that the same area is maintained after the gun is fired you cannot but come to the conclusion that Professor Barlow's fundamental formula is correct. I have stated that it is impossible to more than double the strength of a gun by any amount of shrinkage you could put on. No doubt if you have a gun that is perfectly dense, and it is perfectly impossible to compress its fibre by shrinkage, and if you have two coils of infinite thickness, the one of which is shrunk on the other, you may possibly theoretically exceed this limit, because to begin with, there is a certain amount of tension in the outer coil which is required to bring the inner coil to its limits of compression, and in extending the inner infinite coil, you further extend the outer to double what it already was, and then the extension of the outer coil is brought up to three times. If, however, you at all limit the thickness of your coils, I maintain you cannot get more than double the strength. For instance, take a gun with its inner coil ½ calibre thickness, and its outer coil, one calibre thick. These will be found if you adopt Barlow's law, to work within the limits of compression and extension and give half the useful effect of the metal. Whereas if the same thickness were made in one piece, it would give only one-fourth of the same amount and the ratio of strength of these two would be as two to one.

If you go beyond a calibre and a half in thickness, you will certainly get into manufacturing difficulties.

It is impossible to so adjust the shrinkage that you can be certain that you get the proper amount; there is no doubt when you put on shrinkage it wears away. You can put it on with perfect accuracy to begin with, and in time it will lose its shrinkage. We have, however, two or three things which if properly used help us in this respect. No doubt the shrinkage is lost, but there are some circumstances connected with gun making that prevent our losing the whole of it. For instance, the heat of firing expands the inner tube, so that the heat itself creates a shrinkage. I have known guns proved very severely with very heavy charges, when manufacturers have insisted that they should have what is called a "warming" charge, simply because it is a great safeguard for the gun, and expands the bore, and gives all the benefit of shrinkage. The other point I want to insist upon is this: you must make the inner tube of some material that will accommodate itself in this way to the outer tube. That is the great secret of the success of Sir William Palliser's gun. He has a rigid material in his cast iron and he leaves it in a state of quiescence and puts in something soft inside the bore which either by heat or tension accommodates itself to the outside coil. The outside coil bears a far greater proportion of the strain than the inner coil does if it is properly adjusted; the curve of tension does not descend so rapidly; the loss of strength in the outside coil does not decrease so rapidly. Its strength always depends on some proportion to its radius.

For instance, the law I tried to establish by Professor Barlow's theory, was that the value of a coil depended on the ratio of its inner to its outer diameters; of course if the radius of the coil is large, the ratio is more favourable to the large coil; and if you put an inner coil, you get the strength of the outer coil with the pressure bearing on a smaller area, and thus it is very much more favourable to the gun. That I believe to be the secret of the success of the Palliser gun. Mr. Longridge is quite

right in supposing how well they were adapted for small guns, and how remarkably well they fulfilled their conditions, at the same time disagreeing with Sir William Palliser as to their being extended to larger guns. But why should not we carry out the same principles to our heavy guns? Why not have a good, thick, hard steel coil on the outside, and a softer one on the inside, so that it should fit itself to the outside coil; I would not say the whole of it should be hard; but is there no way of tempering the iron so that the tempering shall be greater on the outside of the coil, and be more elastic on the inside? Those are the points that manufacturers and mathematicians should direct attention to I must say I have been very pleased with the lecture, and with these few exceptions, I fully agree with what Mr. Longridge has said. As to the means of carrying it out by the wire or any other system, that is a matter of practice; but as he stated the chase of the gun should be as light as possible, and the breech as heavy as possible. My own gun quite separates the breech from the muzzle. I do not think we can have a heavy tube that does its full amount of work; you cannot have strength in proportion to the thickness of your metal, and that being the case, let us seek for some stronger material, in a light tube doing its work thoroughly well. The reason for the thick guns has been the fact that we must provide for the recoil. People get an idea that the strength of a gun depends on the thickness, whereas the usefulness of that metal is only to give inertia and prevent too great recoil, and as Mr. Longridge says, it is very much easier to provide that weight with cast iron than wrought iron. With steel also we can possibly reduce the thickness of coil.

Sir William Palliser: I do not propose to make many remarks about gun construction. I rather wanted to express my great sense of gratitude to Mr. Longridge, for the very kind way in which he has spoken about me. I heard what he said with equal pleasure and surprise. There is one thing in particular of which I have been very anxious to attain some recognition, and that is my proposal as regards the closing of the breeches of guns. The method which I proposed, and which is now universally made use of, has never been thoroughly understood, nor, at all events, generally acknowledged. This is the first occasion on which I have observed that it has been completely understood and fairly acknowledged, and I am, in consequence, very much obliged to Mr. Longridge. There can be no doubt that either iron or steel when drawn into wire is enormously increased in its strength per square inch. The smaller the wire becomes, the greater its strength becomes per square inch, and I feel sure also—(I do not say I agree with Mr. Longridge in proposing a cast iron tube)—however that may be, I feel sure that an interior tube, if bound up in the way Mr. Longridge proposes, by steel or iron wire, put on in the way he describes, would give us an enormously powerful tube, and such a tube inside the casing would give a very powerful gun indeed. I hope a trial will be given to Mr. Longridge's system. We must remember it is a long time since he first brought forward his ideas, and that he is one of the fathers of the principle of gun construction which embodies methods for combating the phenomenon discovered by Barlow, namely, that the interior of the gun was subjected to the greatest strain. Mr. Longridge was about the very first to suggest rules and theories to meet the difficulties caused by that circumstance. He has devoted an immense deal of learning and experience to the subject, and nobody would be better pleased than myself to see a fair trial given to his gun.

Mr. Arthur Rigg: Mr. Longridge noticed the necessity of separating the longitudinal from the transverse strain, and in reference to this subject if you take any portion of the surface of the bore of a gun, and subject it to a circumferential strain, and also to a longitudinal strain at the same time, there is a resultant of those two which gives a cross strain to the metal that under certain circumstances is considerably greater than either of the two strains alone. Mr. Longridge has illustrated a method for resisting or reducing longitudinal strain by putting a large heavy mass behind the bore of the gun. In the year 1867 I took the trouble to collect together drawings of a great number of guns with a view to investigate this subject and then read a paper before the Society of Engineers, illustrated by diagrams which are now here to tell their own story. One diagram illustrates two of the American guns, the Columbiad and the Navy guns, each with an enormous amount of metal behind the breech. The old English 68-pounder had considerably less proportion of metal

behind its breech, and here is the Russian Blakeley gun which has a very small amount of metal at the breech to resist the longitudinal strain. Then the Parrott guns used at the siege of Charlestown form excellent illustrations of the necessity for a heavy mass of metal behind the bore to resist longitudinal strain. A 200-pounder, which burst at the 230th round, shows a very small proportion between the breech and the chase of the gun, while one gun only showed a very high endurance, and it was a 30-pounder, which burst at the 4,606th round. In this unique example, the breech bore an almost disproportionate size as compared with the rest of the gun, and shows the absolute correctness of the principle which Mr. Longridge has adopted, and indeed one of his own early experiments shows exactly the same thing. A 3-inch wire-bound gun was placed against a wall and fired for some time, but directly it was removed from the wall and allowed to recoil, the breech blew out.

Mr. Longridge: It was hung up by the muzzle when the breech blew out.

Mr. Arthur Rigg: The wall acted as a heavy breech for the protection of the gun. The system Mr. Longridge has carried out is precisely the same as Major Morgan's, only Mr. Longridge attaches the gun to the breech, and as an engineer I should say that attachment is not sufficiently strong. I thought it would be interesting to point out these old examples of exactly the principle which I first showed in 1867, which Major Morgan adopted long ago, and which Mr. Longridge has now brought before us.

Commander Gurdon: I should like to ask Mr. Longridge whether he thinks it possible that the bursting of the "Thunderer's" gun was caused by some bolt dropping out of the hydraulic machinery connected with the loading and left in the chamber of the gun, the next round becoming jammed by that bolt and thereby bursting the gun.

The Chairman: We have had a most interesting lecture, and one which will be of great value to the profession generally, and to all who have studied the subject. Some of the points are salient points, and we see that the objections now entertained to the use of lighter ordnance principally rest on the fact of the recoil not being sufficiently absorbed. I think the meeting will recollect that Colonel Moncrieff's improvements do provide for this by utilising the recoil, so that a lighter gun may be employed. Under his system you may have lighter and stronger guns, and not only not suffer from the recoil, but make it of practical service. There is no doubt that Mr. Longridge has put the material with which he manufactures his wire gun into the very best form to resist tensile strain, and so long as the longitudinal strains which would otherwise blow off the breech, are met by the other arrangements, I conceive that there could be no objection to so building up a gun. I think it would result in giving us a very strong gun, a very easily made gun, and one which is likely to be an extremely economical gun as compared with the enormous price now charged for our very large guns, £16,000 each for the 100-ton gun. I think it is a subject which may fairly receive the attention first of those who will be disposed to study the theory, and then it should, if fulfilling the conditions theoretically desirable, be recommended for experiment on gradually increasing scales. I am quite sure that any one who has devoted so much attention to the theoretical part, and has striven so much to carry into practice his ideas with so large a measure of success, fully deserves at the hands of the country such further trial as may eliminate any mistakes or prove any merits possessed by the system he so ably recommends.

Mr. Longridge: I have very little to say in reply. With regard to the observations made by Major Morgan, I am sorry to see that he still sticks to Professor Barlow's formula. I myself cannot understand how a gentleman of his mathematical attainments does so. It is impossible that I can enter into a mathematical demonstration here, but I put it, not upon my own shoulders at all, I simply say that my demonstration is exactly the same in result as was arrived at recently by Professor Hopkinson, who is a very eminent mathematician, and previously by Professor Hart of Dublin,—by Cauchy, by Lamé, and other eminent men. Therefore I have not the slightest doubt in my own mind that Professor Barlow's theory is entirely wrong and consequenetly it cannot be practically applied with advantage.

To come then to the practical difficulties which Major Morgan said there were regarding shrinkage, I beg to say I have had in the early part of my life very great experience in actual practical work. I have worked with my own hands for many

years. I understand the manufacture of iron perhaps as well as most people, and the manipulation of it and its treatment in various ways. Therefore I cannot sit down simply under the imputation that my notions are purely theoretical, and that there are practical difficulties in carrying them out. I utterly deny it; I say there is no difficulty whatever in carrying out the building up of guns practically with proper shrinkage, provided you first of all subject your material to sufficient tests and ascertain what its qualities are. That is the point where we are sadly behindhand in this country; they have no means at Woolwich of ascertaining with sufficient accuracy the properties of the materials they deal with. Their test machines are utterly unfit for the purpose. The only testing machine that I know of, and it has scarcely yet been brought into practical use, is a method of measuring the extensions, which was shown the other night at the Conversazione of the Civil Engineers, a very beautiful thing, invented by Professor Kennedy, in which he can get with very great accuracy a record of the most minute extensions or compressions and the permanent set. With an instrument of that sort there can be no excuse for not testing every portion of the material that is used, and ascertaining what its qualities are. There are enormous differences even in the Ridsdale iron, which varies to the extent of 100 per cent. in different specimens, consequently, unless you do ascertain for every gun the nature and disposition of the material with which you are going to deal, a formula is of no use at all. If that is done there is no practical difficulty in building up a gun. When we come to speak of wire the thing is perfectly simple. There is no calculation except the calculation of the strains. You roll on the wire, and as you roll it on you measure the strain with most complete accuracy, therefore there can be no mistake whatever about it. With regard to wire guns, I myself have not been able, of course, to do very much. The 3-inch breech-loading gun was quite successful. It was a gun in which the inner tube was of cast iron barely half an inch thick, bound round with wire, and it was fired over and over again with 2 and 2½ lbs. of R.L.G. powder, and 12 and 16 lbs. shot, without the slightest injury. It was, as I said, a breech-loader, and there was no longitudinal strain on the tube whatever. The breech-closing arrangement was so perfect that I have laid a cambric handkerchief over the breech during firing and it was not even soiled.

The question of longitudinal strain in the gun represented by the large diagram has been rather misapprehended. Those bolts are not intended to take the longitudinal strain at all; they are simply to bring back that outer casing which is only adopted for the purpose of protecting the wire. This casing is in the diagram shown as divided from the breech. I could have made the breech end open and put the tube in and then filled up the breech as Sir William Palliser has done, but in this case I have simply divided it through here. It does not touch the tube, it is just a casing on the outside to protect it. The only object of these bolts is to bring the casing back when the gun recoils. These are the trunnions placed behind the breech end of the chase, so that there is no strain upon the longitudinal part of it. The only strain is simply a strain due to the inertia. In breech-loading guns, of course, I manage it in a different way. As regards the wire system, it has been tried in America. Woodbridge's gun is built on the wire system, but in my opinion they have completely spoilt the gun, and made it cost an enormous deal, by casting an immense mass of bronze around the wired tube. This has injured the gun and made it cost three times as much as it ought to have done. In France they have made several guns which have been perfectly successful. I hold a letter in my hand from Captain Schulze of the "Ecole Polytechnique," and he says, "I approve "entirely of the theories which you have exposed so clearly. I think guns made of "steel wire have a great future before them, but I am bound to acknowledge that in "your country as well as in ours new ideas have very great difficulty in bringing themselves forward," and so forth. He says the trials which are still going on are so far entirely successful. I am quite sure by adopting this principle, the construction of the guns will be enormously simplified, and the time occupied in their construction will be decreased to one-fifth or one-sixth of what it is at present. The cost will also be greatly diminished; in fact I have had offers from manufacturers to make a gun of 100 tons, constructed on my principles, at a cost of from £35 to £40 a ton.

With regard to the question of the "Thunderer" gun, I shall be very happy to give Commander Gurdon a copy of a letter which I wrote to the First Lord, in which I pointed out my own opinion as to why that gun did burst. I do not think it was from any bolt of the hydraulic apparatus getting loose, because in the first place, they would have seen that a bolt was missing, and in the second place, when the charge was put in, it would have been pushed up to the breech end, and there would have stopped.

Captain GURDON: I meant whether the bolt was dropped in the act of putting in the charge that burst the gun.

Mr. LONGRIDGE: They would have found there was some bolt missing in the hydraulic apparatus. I am not sufficiently acquainted with the nature of the apparatus to give a decided opinion, but my own conviction, which amounts to certainty, is that the gun jammed by the shot leaving the rifling and sticking. I have the most perfect conviction that if we were to try the other gun double loaded and fire it, the gun would stand it, and would not burst. I believe the "Thunderer" gun burst simply because the shot jammed. In conclusion, I have only to thank you for the attention with which you have listened to me.

The CHAIRMAN: I am quite sure you will permit me to return our hearty thanks to Mr. Longridge for his paper.

Evening Meeting.

Monday, June 16, 1879.

ADMIRAL SIR GEORGE ELLIOT, K.C.B., in the Chair.

ON THE MOST POWERFUL IRONCLAD.

By Rear-Admiral J. H. SELWYN.

"THE most powerful ironclad" should (I think it will be admitted) possess the following qualities and powers, and fulfil the following conditions as nearly as may be.

(1.) She should have the greatest number of the most powerful guns, and they should be capable of delivering the greatest weight of shot per minute on a given mark situated on any given point of the compass.

(2.) She should have the greatest speed for the longest time, *i.e.*, she should have the least consumption of, and the greatest capacity for, fuel, consistent with the first condition as to armament.

(3.) She should have the greatest rapidity of turning, in the smallest space, and a power of ramming by any contact whatever.

(4.) She should have the steadiest gun platform, combined with the greatest stability.

(5.) She should not be liable to capsize under any conditions.

(6.) She should be as nearly as possible unsinkable, as long as her motive power is available.

(7.) Her engines and machinery should be at least duplex, and should have the least possible liability to fatal accident, damage, or decay.

(8.) She should have the least possible liability to fatal attack by guns, torpedoes, or rams.

(9.) She should have the least draught of water with which all the other advantages can be obtained.

(10.) She should weigh no more, and cost no more, either to build or to propel, than any other carrying the same number of guns, and possessing equal advantages.

(11.) She should behave fairly well under all conditions of winds and waves, and the buoyancy should rapidly increase with every increase of immersion, however caused.

(12.) She should be fairly comfortable and healthy as a sea habitation.

I venture to think that there is no insuperable difficulty in fulfilling concurrently all these conditions, if we abandon prejudice, embrace progress, and condescend to examine particulars.

I propose first to consider some of the most powerful ironclads now existing or projected, to see how far they fulfil each of the above requirements.

For this purpose I have selected the three Italian ships "Duilio," "Dandolo," and "Italia," which have been devised to carry the most powerful armaments ever proposed afloat, and in many points represent the most esteemed types of the day, for offence if not for defence, while they do not, in this country at least, arouse any personal susceptibilities.

Condition No. 1.

They do carry the most powerful armament we have yet seen, but the second part of the condition is only very partially fulfilled without yawing. Taking the "Italia" as to be armed with six 100-ton guns, we have 13,500 tons of ship devoted to the purpose of firing 108 rounds in the hour, of which 8 per cent. may be expected to hit, in a naval engagement.

Condition No. 2.

With our present knowledge we may affirm that neither their coal supply nor their expenditure of it is in any way satisfactory.

Condition No. 3.

As to the first condition, their length and small rudder power prevent the attainment of it in any satisfactory measure, four miles would be the smallest circle in which they could turn at speed. As to the second, their power of ramming is confined to the bow as in all existing types of ship.

Condition No. 4.

They probably possess as steady gun platforms and as little initial stability as any others in which guns and turrets are carried high above the water, that is, their maximum angle of stability is below 45°.

Condition No. 5.

Like all of their congeners, the angle of 45° is the limit of their inclination with safety, and their normal position as floating bodies is "bottom up" if they are required to carry side armour.

Condition No. 6.

This is entirely unfulfilled. Rams or torpedoes would sink them immediately, and if shots had penetrated the bulkheads supposed to be watertight, much less damage would effect the same result.

Condition No. 7.

The engines and machinery are duplex, but are certain to decay

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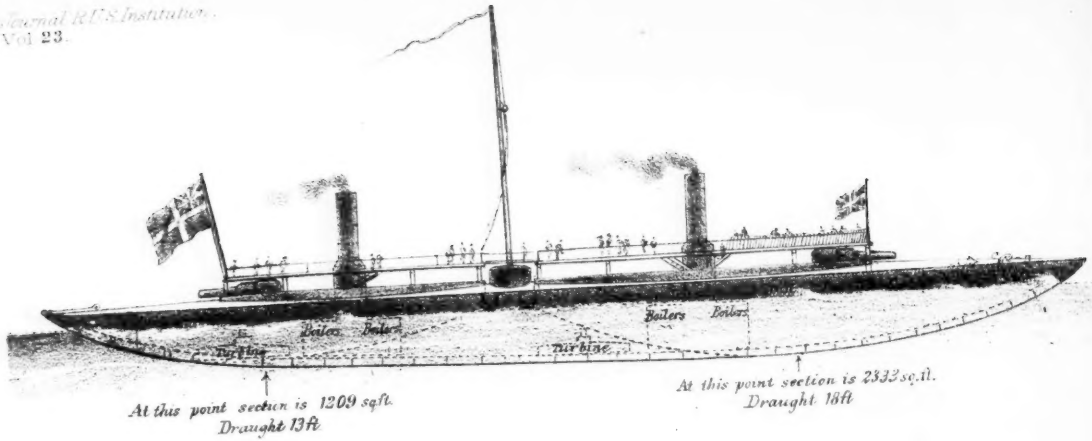
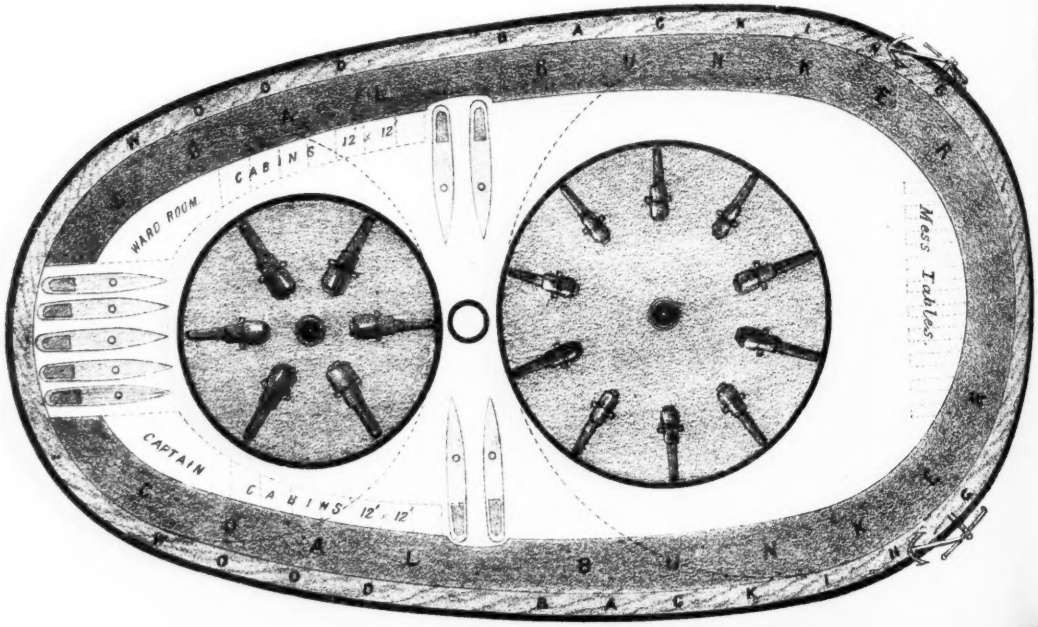


H. M. S. BRITANNIA.

16 Guns, — 16,300 Tons. — 23,000 I. H. P. — Speed 16 Knots for 10 days.

Scale ⅛ inch = 8 feet



DECK PLAN.

Harrison & Sons Lith. 59 Martins Lane W.C.

(within a very short space of time as regards the boilers) and are extremely liable to fatal accident and damage, as to both boilers and screw.

Condition No. 8.

They are absolutely liable to fatal attack by torpedoes or rams, and considerably so by shot, shell, or under-water rockets.

Condition No. 9.

The draught of water is very great and unfits them for many harbours and coasts, in short, this condition is practically ignored in all modern ironclads, yet we shall see that it could easily be obtained in a different form of hull.

Condition No. 10.

Here the cost to build is, though probably not greater than in other ships of the modern construction, enormous in relation to the offensive power carried. As the offensive power is the *raison d'être* of a man-of-war, so it is the only true test of efficiency with equal speeds and economy of fuel.

The cost of propulsion is also much higher than it ought to be if modern science were more consulted.

Condition No. 11.

We may assume that these vessels will behave fairly well in all circumstances of winds and waves, since the weights are at least as well disposed as in any others of their class.

Condition No. 12.

We may also assume that they will be fairly comfortable and healthy as sea habitations.

I am now to show that there may be a mode in which the twelve conditions laid down can be in a very much larger measure concurrently fulfilled, and though I do not venture to anticipate that the changes, to which I draw attention, will be generally approved or quickly adopted, yet I think, the time will come, when the study of them will be found to have been useful, since there are, undoubtedly, difficulties arising in our modern practice, from which the present system provides no relief, and which become more serious with every forward step in the sciences of attack and defence.

As all ships must have a name by which to refer to them, and as the type-ship I have selected on the other system is called the "Italia," I have given this the name of "Britannia."

If we take the length of the "Italia," 400 feet, as our limit, and merely increase the beam very largely, to 220 feet, we shall have the principal dimensions. On the water-line there will be respectively 380 and 200 feet, the overhang all round amounting to 10 feet.

To commence the construction of this vessel, the draughtsman will take two segments of large spheres. The first will have a radius of 265 feet. The segment will have a diameter of 200 feet and a depth of 18 feet.

The second sphere will have a radius of 200 feet, and its segment will have a diameter of 150 feet and a depth of 13 feet.

If placed close together, these two would make a length equal to the sum of their diameters, viz., 350 feet; but they are to have an interval of 30 feet between them, and then make up the length of 380 feet (above spoken of as the water-line length).

The space between the bottoms of the two segments is now to be filled in and the lines fayed, and we have a body resembling the under-water section of an aquatic bird.

It may be also called a centre-board or spoon-shaped bottom.

The greater segment will have a capacity of....	8,165 tons.
The lesser segment a capacity of.....	3,315 „
The intervening body a capacity of.....	4,836 „
Making a total of	16,316 „

It will be understood that I do not advocate the building of such a monster vessel at once without further study and experiment. I only put before you a type, in order to show what results might possibly be obtained under such circumstances, and how far such a structure might be likely to fulfil the twelve conditions first laid down.

Displacement	16,316 tons.
Total contents in cubic feet	1,000,000, or about 32,000 tons.
Length on deck	400 feet.
Length on water-line	380 „
Beam on deck	220 „
Beam on water-line.....	200 „
Area of midship section (at semi-diameter of foremost segment)	2,333 sq. feet.
Area of intermediate body (below water-line)	1,823 „
Area of after segment (below water-line)...	1,209 „
Area of wetted surface	66,000 „
Draught forward (at mid-section)	18 feet.
Draught aft (middle of after segment).....	13 „
Height of raised deck above keel	45 „
I.H.P.	23,000
Proportion of I.H.P. to one square foot of mid-section	9·8
Proportion of I.H.P. to one square foot of wetted surface	0·348
Weight of armour, including plating of decks 2 inches thick, edge-plating, and gun-pit plating	5,000 tons.
Weight of armament, shot, shell, carriages, &c.	4,400 „
Weight of coals, in bunkers	2,300 „
Consumption of coals per day	210 „
Weight of hull.....	4,616 „
Speed.....	16 knots.

Guns—8 of 80 tons and 8 of 100 tons, or 20 80-ton guns, all mounted on Colonel Moncrieff's hydro-pneumatic carriages, in two separate gun-pits, revolving on turntables, so that each gun fires as it comes round, and there is no delay from loading.

The engines and boilers are on Perkins' plan, giving one indicated horse-power per hour for less than 1 lb. of coal, with entire immunity from dangerous explosion, unlimited durability of the boilers, and easy repair should accidental damage take place. The propellers are hydraulic, and will pump out, at the same time that they drive, the ship, even if two holes, each 10 feet square and both at the lowest point of the bottom, should be made by a torpedo, so long as neither affected the motive power. The engines may be quadruple if desired, but will certainly be duplex. There will be no deadwood or keel, and no rudder will be necessary, the steerage being perfectly easy with even one jet going out of eight, that would probably be used, of 22 inches diameter each, with a pressure equal to a head of 95 feet, capable of giving 2 tons of thrust with each 100 indicated horse-power, *i.e.*, in all 460 tons, or 441 lbs. per square foot of mid-section, and 156 lbs. per square foot of wetted surface. It will be useful here to state that the "Alexandra," with a displacement of 8,442 tons, and a wetted surface of 28,200 square feet, was driven 15 knots with ·301 of a horse-power to one square foot of wetted surface. We are using here ·348 of a horse-power, and expecting one knot more, calculating, which I think is below the truth, that the hydraulic propeller properly applied is not more efficient than the paddle or the screw. I am perfectly aware that it has been stated that the hydraulic propeller has not yet shown an efficiency equal to either, but, if true, that is because while centrifugal pumps were known capable of giving 80 per cent. of useful effect, a kind of turbine was used in the "Nautilus," "Waterwitch," and others, only capable of giving about 45 per cent. of useful effect with a given indicated horse-power, and other mistakes were made which I hope will not be repeated, seriously deducting from the efficiency which might otherwise have been fairly expected.

I have said so much of the power provided to drive this vessel because it has been authoritatively stated that she could not be driven 16 knots by it. Now, I am not aware that there is any other mode of measuring the resistance of bodies driven through water than those to be found in all standard works on the subject, namely, skin resistance and midship section resistance, with coefficients applied, which depend, in the skin resistance, on the roughness of surface, which is identical for all iron or steel structures newly built and painted, and in the midship section resistance, on the fineness of the lines of entry and exit. In my opinion there ought to be a third consideration derived from the depth and consequent weight of the column of water disturbed, and if this be so, the difference between 18 and 30 feet draught will be sensibly felt. In this form of bottom there is no floor, the whole of the under-water body is composed of lines of entrance and exit, and these lines are at least as fine as any that have yet been applied to floating structures of such magnitude. Therefore, I fail to see why the same speed is not to be expected with

an equal force applied to produce it, not subject to any intermission, as is well known to be the case with the paddle when rolling, and the screw when pitching, and I am not afraid to predict that considerably greater speed will be realized with the hydraulic propeller in proportion to indicated horse-power, than has ever been done with any other form of propeller whatever, whenever it is scientifically applied. This I do, not from any crude opinion, but from careful consideration and calculation of the forces applied, and the mode of their application, combined with a study of the data already available on the subject, of which Admiral Elliot has contributed so much. The superior qualities which are shown as to the length of time (10 days) during which the full steaming power can be exerted, are, of course, mainly due to the Perkins system, and could be, in a measure, applied to any other form of vessel (if such there be) in which 2,000 tons weight can be put in or taken out without inconvenience or danger. Here, on an emergency, the quantity of coal could be doubled with no other inconvenience than sinking the vessel at starting 1 foot 3 inches beyond her normal load-line, and would reduce the indicated horse-power per square foot of wetted surface to a little more than the "Alexandra," viz., 0·313 against 0·301. Thus, from whatever cause the weights may be increased, which may be found necessary, no danger is thereby incurred; the thickness of the deck armour may be brought up to 3 inches instead of 2; the side armour may be carried towards the keel, or the calculations of weight of hull may be wrong to the extent of 2,000 tons, and as it is a very difficult thing to say with steel what thickness of bottom is required, and as I have not had any assistance from skilled naval architects, I may have made such a mistake, though I have no reason to think so, and yet no serious inconvenience, certainly no danger, will result.

No one will be prepared to contest the fact that the armament I have proposed would be vastly more powerful than any other, but I have yet to show that it will put more weight of shot per minute on a given mark anywhere round the horizon.

Two guns in the ship can be fired once in each half minute—at any mark on either beam, quarter or bow—in succession, or at two marks, one on *each* beam, quarter or bow, in each minute. Right ahead or right astern one gun can be fired each half minute.

At any enemy within short distance this speed could be considerably increased.

Now the rate of fire with large guns being about 3 shots in ten minutes, this system will compare as follows in shots per hour:—

On one beam,	6 guns in a turret ship will have fired	108 shots	= 108 tons.
Quarter or bow,	16 guns on revolving platforms will have fired	240 shots	= 210 tons.
On both sides,	6 guns in a turret ship will have fired	54 shots	= 54 tons.
	16 guns on revolving platforms	120 shots	= 105 tons.
Right ahead,	3 guns in a turret ship will have fired	54 shots	= 54 tons.

Right astern,	10 guns on revolving platforms will have fired	120 shots	= 90 tons.
	3 guns in turrets will have fired	54 shots	= 54 tons.
	6 guns on platforms will have fired	120 shots	= 120 tons.

Showing that with this system double the gun power can be obtained with less than one-fourth more tonnage than the "Italia."

So much for the first two conditions.

Now for the turning and ramming power.

As the force of the jets can easily be exerted in contrary directions with a leverage due to two-thirds of the total length, and as the resistance to turning is but little greater than that to forward motion, this vessel may be expected to turn at the rate of a complete revolution in one minute, *i.e*, as her periphery is 1,024 feet, at the rate of 17 feet per second, in her own length.

Now, any body moving at the rate of 17 feet per second, and having a weight of 16,316 tons, strikes a blow of 4,000,000 foot-tons.

Will not any part of such a periphery, shaped like an axe-edge driven at such a speed, destroy anything that can be opposed to it, whether armoured or not?

Condition No. 4.

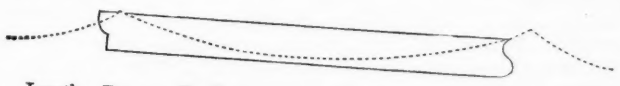
There can be no doubt that this will be an absolutely stable ship, and in all ordinary weather the waves will simply lift her, without causing any motion either of pitching or rolling, so that the gun platform will never be more than two degrees out of the plane. Let us see what she will do in a heavy sea, where the waves are equal in length to herself.

Length of wave, 400 feet
Height from hollow to crest, 30 feet } one in 13·3.

Let us take it as 1 in 12, or 1 inch in 1 foot, and look at the diagram. 8 feet increased immersion will be equal to another 16,000 tons.

Is there any reasonable probability that this will take place, and if it does where can the water get in? But there may be a shorter sea into which she will plunge; by another diagram we may see what will then occur.

The "Italia" has a beam of 74 feet nearly. We will suppose that she carries two-thirds of this right forward, which she certainly does not, and that half her length, viz., 200 feet, is partly submerged when she pitches, thus—



Length. Beam. Depth.
200 × 50 × 49 = 490,000 ÷ 2 = 245,000 cub. feet immersed.

Under the same circumstances the immersion of the "Britannia" would be, 200 length by 200 beam by 18 depth = 720,000 ÷ 2 = 360,000 cubic feet immersed.

I have given all the advantages to the "Italia," and more than she could fairly claim; but why should the broader ship behave worse than the narrower, when the former increases her buoyancy more rapidly?

The question becomes even more absurd if the application is made to a beam sea, on account of the far greater leverage as well as buoyancy given to the broader ship.

The following sea will be very nearly the same as the bow sea, because, although the area will be less, the velocity will also be less, by the forward motion of the ship.

What has here been adduced will meet sufficiently the idea of capsizing, which can never take place with this type, and also the conditions which refer to behaviour at sea.

As to unsinkability, in addition to the usual subdivision of the interior, there is the whole power of the engines available to pump out the ship; this has been referred to in the description of the engines, and does not require further notice here.

As to fatal accident, damage, or decay to the engines and boilers. The only provision that can be made is the reduplication of engines, so as to diminish the probability of such damage, as much as possible; and this, which could scarcely be carried farther with screws than has been done, can easily be provided, to almost any desired extent, with the hydraulic propeller.

As to the boilers, however, it is far otherwise. Whereas, with the old system, no boilers could continue for long to carry the pressure for which they were designed without danger; with the Perkins system the boiler never wears out, and can always be pressed to double the working load; whereas former boilers, if injured, were fatal to all around, and could only be replaced with great expense and difficulty; these will never, if damaged by violence, hurt any one or anything near them; and the damage, however arising, can easily be repaired by the ship's own resources. Of course, these advantages are not confined to this form of vessel, or to navigation of the ocean, but are a boon conferred on every user of steam power for whatever purpose.

We will now pass to the question of liability to fatal attack; and first we will remark that, although this vessel might injure her friends by inadvertence, yet she could scarcely be injured by them, as was the case with the "Grosser Kurfürst" and "Vanguard." A very determined attempt to ram her would indeed probably result fatally for any ironclad now known, since their spur or ram bow could not touch her bottom, and her edge might seriously injure them. I have no doubt a spur might be devised by Admiral Sartorius which would be formidable even to her, but I think it would not increase the turning power of the vessel to which it was applied, and the advantage in this respect would remain with the "Britannia."

I cannot suppose that a lessened target will be without its advan-

tages in diminishing the chances of hitting, and I confess that I think the under-water attack so far more formidable than any amount of shot, only 8 per cent. of which are likely to hit, that I am disposed to pass lightly over the fact that there is here very little chance for a shot to do any damage whatever. In close action the upper decks, which are in fact the lids of the gun-pits, can be lowered down, supported and raised as they would be by hydraulic presses, and then the guns rise and fire through shutters, as explained by Colonel Moncrieff some time ago in this Institution.

I do not profess to have discovered a means of obviating the torpedo attack entirely, but in this form of vessel a great deal can be done to glance them, or cause them to explode harmlessly, specially while at anchor, and at any rate the pumping power is a valuable means of prolonging the time during which a vessel will float, when seriously damaged, if nothing better can be done.

The draught of water is so moderate, when compared with any other of the same capacity, as not to require any remark from me to enhance its value, especially when applied to coast or harbour defence. One such ship as this would render any harbour secure against naval attack, and could proceed rapidly to any point where her services might be required, without any anxieties about fuel.

I have no exactly reliable data as to cost per ton, but I am certain that 16 guns of such a character cannot be put afloat on any other system at the same cost, and I believe that at present she could be contracted for at not much over 20*l.* per ton of dead weight carried, for the hull and engines.

She certainly would not cost so much as four vessels like the "Dandolo" and "Duilio," and that is a fair comparison of gun power, and her weight, as we have seen, is also far less, since four of them would displace over 40,000 tons.

As to comfort and healthiness as a sea habitation.

You will remark that the foremost gun-pit is 122 feet in diameter, and the after one 100. These large openings on what we may call the living deck, secure perfect ventilation, and when the decks over the pits are raised, may be closed in, to any extent desired, by glazed lights; we may use also dead lights at the fore part in bad weather, or even all round if necessary. These can be made even more secure against the blow of a sea than any ordinary bulwarks, since they can be held at the top as well as the bottom. If such weather as would cause battening down to be resorted to, comes on, and I much doubt this ever occurring, then perhaps the deck would be lowered down on the pits, and special cowls or other modes of ventilation must be resorted to, but for all except extraordinary circumstances, she will be as healthy as an old three-decker.

As the whole crew, officers and all, can be berthed on the living deck, there will be no difficulty as to comfort.

You will easily see that I have not neglected a provision for the mosquito fleet of steam launches, which must now accompany every large ironclad. All should be provided with the same kind of engines and boilers, the same means of propulsion as the mother ship. They

are to be launched and got on board up inclined projecting ways, to be stowed below deck, going down through shutters, and may be twelve in number if thought desirable. Any light boats may be carried on deck between the two pits if necessary, and be sent down below in heavy weather only, or on going into action when the torpedo launches would be out of the way.

The coal is stowed in bunkers all round the ship. For this purpose a space 25 feet wide, 10 feet deep, and 800 feet in length is sufficient, but might be increased at will by 2 or 3 feet in depth.

There is shown in the diagrams an iron edge round the ship, and an iron wall round the pits. The latter is calculated at 4 feet in depth (*i.e.*, equal to the rise of the deck from gunwale to midships) and 30 inches thick. I think the outer edge might be 20 or 22 inches thick, and taper downwards to, say, 4 or 5 inches at the water-line; but all this I have left undefined, merely providing more than 1,400 tons of armour for the purpose, besides that for the pits and deck.

Behind this armour would be a wood backing of, say, 8 feet thick, and inside that come the coal-bunkers. So that the chances of any shot entering the ship, or any external blow fatally injuring her, are, I think, reduced to a minimum, consistent with the weights to be carried.

The steering can either be done from the conning-tower or any part of the deck by hydraulic power, of which very little would be required.

In considering the question of weight of hull it will be well to recollect that there is here no deadwood, or keel, or stern-post, or rudder, or screw; that every square foot of wetted surface contributes to the buoyancy of the whole structure, and that the above things increase very considerably the weight to be provided for, and the resistance in any other type of vessel.

Also, in calculating weights and costs of engines, it will be necessary to remember that we are getting one indicated horse power for 1 lb. of fuel, and not two, that we are doing without the enormous weight of water in the boilers, the same fresh water in far less quantity being used over and over again, subject to a small waste only per day, that the life of the boilers is indefinitely prolonged, and that no mishap to the screw can disable the vessel at a critical moment, the cost of which it would be impossible to calculate, since it may drive the ship into port, or even involve the loss of a great battle.

Now, although some persons, for whose authority I have great respect, allow that I may fairly claim most of the results to which I have adverted, they entirely demur to the idea that this vessel can be propelled at the rate of 16 knots by the power I propose, or that if she could be so propelled, she would be easy or safe at sea. Mr. Reed, who was at sea in the "Popoffkás," says that even with that tub-like shape he was surprised to find how easy the motions were, and all our experience of centre-board yachts shows us that, while they are very fast off the wind, with the centre board up, they are equally fast on a wind with it down. In fact, they notoriously beat every deep-keeled vessel of the same tonnage that can be brought against them. The Arab dhow, which has some similarity, as well as the Chinese junk, are

very fast vessels, as I very well know, having chased them more than once. They also are very easy and dry at sea.

Besides this, these gentlemen do not object to the whole body of the ship being under water, with a turret or two above it. They only object when increasing buoyancy is present in the highest degree. Of course, on such a subject there will be many opinions, but these ought to be based on some reliable data, such as are given, as far as they can be, without actual experiment, by the calculations I have submitted to your notice; otherwise, I fear, they must be ranked with other prejudices, which are liable to be dispelled as soon as a fair trial is made.

I am as much inclined naturally, to æsthetics in ships as any one can be, but I recognise the new conditions and necessities, and am willing to "trust frankly to steam," if I see my way to getting reliable steam, to give up wind power if fuel costs less, and to like the ugly ship that will do her work and stop above water, better than even a beautiful one, which carries few guns and has rather a predilection for the bottom. Above all I desire that important economies should be faithfully studied, and quickly introduced, that great improvements should be accepted even if they violate foregone conclusions, and that nothing should be left undone to preserve that proud pre-eminence on the ocean which our forefathers, with so many labours, and at such costly sacrifices, transmitted to all who call themselves the children of Britannia.

TABLE I.—"*Dandolo*" *and* "*Duilio*" *Ironclads.*

Length between perpendiculars	340 ft. 11 in.
Beam	64 „ 9 „
Draught, forward	25 „ 5 „
„ aft	26 „ 5 „
Depth of hold	21 „ 11 „
Area of midship section	1,466·6 sq. ft.
Weight of unarmoured hull	3,395·5 tons.
Displacement	10,401 „
Total weight of armour	2,559 „
Wood backing	239 „
Number of compartments	102 „
Diameter of interior of turrets	25 ft. 9 in.
Thickness of armour at water-line	21·65 in.
Thickness of wood-backing at ditto	23·62 „
Thickness of armour in turrets	17·71 „
Thickness of wood-backing in ditto	11·81 „
Weight of guns, their machinery and ammunition	984·2 tons.
No. of guns	4
Weight of each gun	98·5 tons.
Weight of broadside metal	3·87 „
Bow fire	2·9 „
Stern fire	1·53 „
Length of guns	32 ft. 10½ in.
Breech diameter	77 in.
Muzzle diameter	29 „

TABLE II.—*Engines, &c.*

	"Dandolo."	"Duilio."
Builder	Maudslay	Penn.
I.H.P.	7,900	7,500
Engines	Compound	Ordinary.
Revolutions	80	65
Propellers	2	2
Diameter	16	17·3
Pitch	19	19·6
Speed	14	14
Grate surface	811·6	899·6
Heating surface	22·991	23·775
Pressure	60	30
Coals in bunkers	1,279 tons	1,279 tons.
Consumption per day	211 „	321 „
Full steaming	6 days	3 days 20 hours.

TABLE III.—"*Italia*" *Ironclad.*

Length	400 ft.
Beam	73 „ 10 in.
Draught, forward	25 „ 4 „
„ aft	30 „ 4 „
Height of upper deck above keel	49 „ 3 „
Area of midship section	1,848 sq. ft.
Weight of unarmoured hull	5,000 tons.
Displacement	13,480 „
Double bottom—length	254 ft. 3 in.
„ width	59 „
„ depth	3 „ 3 „
Two longitudinal bulkheads, water-tight compartments	53 in number.
Forty of these above the double bottom, three in the rear and ten forward of it.	
Four water-tight decks: lowest plated with iron 3 in. thick, 8 ft. 2 in. below water-line: second deck 5 ft. above it; battery deck 14 ft. 9 in.; and upper deck 19 ft. 6¼ in. above.	
Twin screws.	
Engines, I.H.P.	18,000
Calculated speed	16 knots.

The CHAIRMAN: We cannot complain that we have not heard a great deal that is very new to-night. I think that this vessel comprises three very important features—the turbine propeller, the circular form of vessel, and the revolving platform, all three, I suppose, having been carried out in their most extreme manner. The subject is very interesting and very large, but I have no doubt we shall have some very sound remarks upon it from some of the gentlemen present. I presume Admiral Selwyn does not confine himself to that size of vessel, but is prepared to compete with any other size of vessel on the same grounds.

Admiral SELWYN: Quite so; this is only a type.

Captain CURTIS: In the discussion on the Prize Essay last year I advocated the adoption of two circular batteries, and I made out somehow or other that they could fire all round with the exception of 45°. I should like to ask Admiral Selwyn whether in his battery each gun is independent of the other, or whether they revolve together on a platform like a railway turntable.

Admiral SELWYN: They can be lifted or trained independently and revolved together.

Captain CURTIS: I believe that the spheroid, or, as I should call this, a segment of two spheroids joined together, is the proper form for any vessel. I remember in going round Cape Horn in a small vessel of 750 tons we had 90 tons freight on board: we were under close-reefed main-topsails, trysail, a bran new fore-staysail and fore-stay. A sea came clean over her and combed the fore-staysail down as if it had been combed down with a steel comb. Now, I think the ship should yield to the sea, otherwise the sea will make a clean breach over her, and if there are any apertures open it will fill the vessel; but the turbine is so efficient I suppose it will very soon clear it. Then with respect to the water-tight compartments, if there is not a thorough communication fore and aft, if she receives damage from a torpedo in one compartment at present I do not see how the turbine is to communicate with it to clear it out. Then I would ask what effect would the fact of that vessel ramming an enemy with the terrific force of 4,000,000 tons have on her own ribs? I advocate that a ship should not strike with so great a force; all the force required to stave any ship that is built is 3,000 or 4,000 tons, as they say if they go on a rock they are very much like cast-iron saucepans, they break up. A ship should have 10 or 12 feet of timber next the iron skin; I say so having seen a 68 lb. shot pass through a spar and I could not get my finger through the aperture the shot passed through; and I maintain if the ship received a shot under water through pine wood the leak will be very small. The excessive broadness of the vessel is, I think, a feature in which there is danger, as the sea might wash everything off the decks. Certainly if I was engaging a vessel of that sort, and could not get away from her, I should land myself on her decks.

Mr. SCOTT RUSSELL: I think I should be deficient in my duty if I did not give very careful study to all that the Admiral has said on this subject, because from the earliest time I have been both an advocate of these circular vessels and an opponent of them; an advocate of them because I think that a circular form of war vessel for certain purposes has very great value; an opponent of them because, although I give them great value, I do not like to hear them called sea-going ships. The advantages of a circular vessel are very many: there is great economy, there is moderate resistance of a certain kind, there is enormous buoyancy, there is great difficulty in being sunk if wisely constructed, there is also less resistance to propulsion than people think; and having stated all these advantages, I may add that I have always backed Mr. John Elder in his propositions about circular vessels. I have also agreed with Admiral Popoff in the desirability of their construction, for certain purposes, but I have disagreed with all who have put them forward as seaworthy ships. Call them floating batteries and I will give them all the praise I can. Now, having drawn this which in my mind is a marked distinction, I will say that the whole of the design which Admiral Selwyn has shown us possesses, in many respects, very high merit. There are several points on which I do not quite agree with him, even looking at the limited view I have taken of the subject. I am not quite satisfied that it is better to have two batteries than one. I want to be assured of some very strong reason for having the two together standing in the way of each other instead of the one circular battery clear all round. I also have a high notion of what you call the jet or the turbine propeller, with only this one difficulty, and I should like to know very much whether the two gentlemen who are here who have advocated that question, and no man more energetically and more wisely than the Chairman, can explain what you are to do when you get into dirty and wrecky water. Is there no difficulty? Because I have always felt a great apprehension from the use of the turbine when I thought of the turbine acting in water where there were fragments of sails and wreck and masts all round about the ship. It seemed to me that these circumstances which you must take into account were very formidable opponents to the turbine and the internal jet. With regard to the jet in many other respects it has very great value, and perhaps one word from either of those gentlemen would satisfy my mind upon this subject.

The CHAIRMAN: I think I can give you an answer which will very much please you. In the first place, the canal for the admission of the water has been abandoned. In the "Waterwitch" at Portsmouth we shut off the canal altogether, because it had always been considered a grave objection, inasmuch as the ship was carrying about a certain quantity of water; in fact, it was so much lost displace-

ment. I made under the bottom of the ship a round hole, and inserted a tube, so that the water came direct from the bottom. The tube was shaped wider at the bottom than at the top, to allow for the free access of the water; and by putting a grating, not of very close meshes, but, on the contrary, very wide meshes, near the centre, you will prevent anything getting into the pump that could not go out of it. In fact, in the "Waterwitch" a man could go in below, and he would be forced out at the nozzle. There is nothing to stop wreckage from going through so long as it is not very large, and if it was very large, the grating would stop it from going in. On one occasion the "Waterwitch" was on shore in the Victoria Docks. What was the result? They set the engines going at full speed; in came all the *débris* from the bottom of the docks, and it was forced out at the side, where there is nothing to stop it; the whole passage through is as large as the hole that admits the water. If the vessel was on shore on a sandbank, say in the Suez Canal, they would have nothing to do but to set the engines going; they would suck in the sand from below the vessel, and force it out at the sides, forming a bank on each side, and as the sand was sucked in from below a bed would be formed for the vessel to float in, and, in fact, the engines would unquestionably bring the ship off any sand. In clay nothing could come in, in rocks nothing could come in; and I think, generally speaking, that floating wreck is near the surface, not exactly under the bottoms of the vessels; but with a grating, as I have said, of 2-inch iron with large meshes, I do not think it is possible for anything to get into the turbine.

Mr. Scott Russell: I am very much obliged to you. Then allow me to say I do think that the jet propeller is a form of propulsion particularly well adapted to the propulsion of this class of ship or floating battery; and I think also that it is particularly well adapted to the manœuvring of that ship or battery, and the only point on which I think I materially differ from Admiral Selwyn is that I like a circular battery to manœuvre itself and to be its own turntable, and it seems to me that a circular vessel with that large battery manœuvring itself and being its own turntable is so valuable that I feel reluctant to alter the circular shape and to take this elongated shape of Admiral Selwyn's. He will give me an excellent reason, I have no doubt, why he prefers the elongated shape and the two circular batteries to the single one. The next point I would take up is one on which Admiral Selwyn is particularly strong, and in a great measure he is right. In the first place, I quite accept his proposition that the lines of this vessel are very long in one direction. True, that is the vertical direction, but they are very long in that direction, and therefore I say that I agree with him in believing that the resistance to that vessel going through the water will be much smaller than is generally supposed. I believe all the experiments that have been tried have proved that it is much smaller than was supposed; therefore I at once admit that the vessel will be capable of manœuvring, that it will be capable of going from the place where it is not wanted to the place where it is wanted, and that, therefore, it will be able to perform some very important functions. I also say I have very great faith in the method here adopted of using, for this particular kind of battery, guns which rise from their place below the water up to the place above the deck whence they are fired. I think it is so admirable a plan that I long to see its introduction into our Service in one shape or another, and for this purpose I think it is peculiarly well adapted. In regard to the arrangements of the vessel in general, I think there can be no doubt that the circular form and the approximation to the circular form is an economical form, and a form in which an enormous weight of material will be carried with comparative economy. With regard to the sea-going, seaworthy qualities of this ship, I have no doubt that there are many states of the sea in which that vessel would behave very much better than she would generally have credit for, but there is one difficulty I have, and I wish Admiral Selwyn would reassure our minds upon that subject; that is, I have very great doubts as to what that ship will do in a heavy head sea, such as one sees in the Bay of Biscay, such as I suppose one might have seen even in the Black Sea or the Mediterranean, when there has been going for a long time a nasty surface wave-drift in the opposite direction to that in which one wants the ship to go. How will she behave against a hard sea under such circumstances? Perhaps she will behave better than other people expect, but in those circumstances I do not expect that she would make very much headway. The points which Admiral Selwyn has raised are so numerous that,

however willing I might be to discuss the whole of them, I could not venture to enter upon the matter so fully as that. I am very glad indeed to hear what he says as to boilers. I believe the time is coming when our boilers will use less than a pound of fuel per horse-power per hour, and will be much safer and last much longer than hitherto. I believe in the efficiency of that system of pumps which has been quoted, and also, in certain circumstances, of the propeller jet, which Sir George Elliot has so long and ably advocated. I believe in the system of armament, that is to say, in the great efficiency which the navy will derive from a system of armament in which the guns go down under the water, and only when they are used come above the water. That vessel, I have no doubt, will have much more stability than people think, she will have more speed than people think, she will be more seaworthy than people think, and will have considerable endurance, and be tolerably safe from running down. I think those are all the points on which I can express any opinion.

Captain GURDON: I am rather at a disadvantage because I did not hear the first part of the lecture, but I would ask, is the gun in the gun-pit, as proposed by Admiral Selwyn, to be left without any protection? The great objection to the "Popoffka," as I always understood, was that the guns were exposed to shrapnel fire. I do not know whether Admiral Selwyn provides for such a fire as that, and if not, could not some chain armour on the principle of the old chain cuirass be devised so that the gun-pits should be covered in time of action.

Colonel CLINTON: I should like to ask how Admiral Selwyn proposes to keep the ship from being swamped when the gun is brought up, and also whether it was not the fact that the "Captain" was lost in that way in consequence of the sea getting into her.

The CHAIRMAN: I do not think it appears that we any of us quite understand how these guns are to be fought. I think if Admiral Selwyn will describe that point it will assist us.

Admiral SELWYN: With reference, Sir George, to your own question as to the size of the vessel being an essential, I think I said in my lecture that I do not propose anything more than a type which is to be studied. How far down it would be worth while to carry this, whether it would be worth while to extend our gunboats carrying a single gun into the spherical form for the purpose of carrying very heavy guns and carrying them very low down, I am not at all sure—you might not choose to carry it as far as that. If you are to have 100-ton guns as your armour-piercing guns, I am quite sure it will not do to carry them on a gunboat of the ordinary type. They are already so unduly weighted that they cannot be expected either to go fast or to behave well at sea. That, however, is not a question into which I have entered. I have simply proposed a broad type; and whether it is to be carried out in a thousand-ton ship or a sixteen thousand-ton ship is a matter of choice.

With regard to the question as to the revolving platform and the gun, you will please to understand these are gun-pits capable of containing all the guns out of sight of anybody, the guns and their carriages standing on a platform which is capable of revolving at the rate of about once in three minutes: that is, the rate at which a gun can be loaded. On those platforms there are the usual racers to enable each gun to be trained independently. It may be so trained to an arc of any description which does not interfere with the next gun to it; the guns have a power of revolution on the platform in close action which makes them fire once every half minute instead of waiting to load for three minutes, and they can be trained when the platform is perfectly stationary so as to give the ordinary fire on all sides at the rate at which they are generally loaded. With regard to the buoyancy in a heavy sea, I thought I had specially touched that point in my paper. I have shown in whatever way you incline this vessel you inevitably immerse more tons of extra buoyancy than you would in any other form. Every 15 inches of increased immersion means 2,000 tons additional buoyancy.

Mr. SCOTT RUSSELL: Then you have some 10,000 tons of spare buoyancy?

Admiral SELWYN: Yes. Therefore, as all floating bodies float in proportion to buoyancy and only refuse to rise out of the sea when they are over-weighted and they have no surplus buoyancy, this ship must necessarily rise more easily because the time in which the wave from the beam will be passing will be longer than in

any other form of vessel of ordinary breadth. There is here not one square foot of surface of any kind whatever which does not distinctly contribute to buoyancy. The time taken by the bow sea in passing under a vessel is of course in proportion to the length of the lines and therefore it rises easily in proportion to the time during which a wave passes. If we have to take a vessel of the ordinary wall-sided type the beam wave comes up to her and suddenly rises up, because it cannot in that moment of time pass under her: the vessel is weighted to the water-line; what is the lifting power of the wave approaching that ship on the beam? It is simply the excess buoyancy which is meant by the level raised up here (Diagram). Therefore ships of this "Italia" type do not lift easily and slowly, but when they lift they lift very quickly. This vessel, the "Britannia," while she would always take the inclination of the wave as nearly as she can, will never have any tendency to libration, or what seamen denote by the various names of pitching, and rolling, and cross movements, but which is really the balancing movement—the libration. The greatest angle at which that ship could ever be found in a sea of this kind is the angle at which you see the sea itself. I think that will be an answer to most of the questions about behaviour at sea. I am sorry Mr. Scott Russell continues to think that this vessel will behave badly at sea. All I can say is, my conviction and that of a great number of my brother Officers whom I have consulted is to the contrary.

Mr. SCOTT RUSSELL: I do not say it will behave badly; I said you won't go very fast against a heavy sea.

Admiral SELWYN: Owing to her never losing any propelling power by pitching and rolling, I think she will go considerably faster than any vessel of the other kind. Then as to pumping out. It must not be understood that this vessel is to have one or two turbines; I should prefer her having eight, and if there be any necessity for pumping out the ship, communication must be made with the compartment into which the water has entered; but in this case it is much more easy to do so, because the pumping power is exerted in more compartments than with the screw. Then as to the speed of revolution for ramming of which I spoke. I gave the speed at which, if she was turning as quickly as possible, she would move round, but I did not give the speed at which I should prefer to ram. I simply say that any general push from her would be destruction. I do not require 4,000,000 foot-tons to do that. 4,000,000 foot-tons is a sort of thing none of us have ever seen, and I think we never shall see it. If you turned this vessel in any direction, and at the slowest speed at which she should be turned, she would still exert a force sufficient to drive in the side of any ship which now exists with very little damage to herself, and that for the reason that the blow is given by an edge, which is in fact a horizontal axe, and you can no more expect to find that edge damaged by striking than you would the edge of an axe by striking into soft wood. There is the great thickness of the iron first, the wood second, and the coal third. It is said that the excessive breadth is a danger, but I confess I think excessive breadth is exactly the contrary. I believe generally the sea breaking on board is a question entirely of the power of the wave to lift the ship. If a ship pressed over by sail and pressed downwards has no power of rising, the wave must go over her; but if that power exists in a very large measure the ship will rise because she gains more buoyancy—she will weather out any gale of wind, and will be as dry as possible. There is one condition I should mention. If you get her in a sea like that of the Pentland Firth, where a gale of wind sometimes encounters a 10-knot current, and where you get a short chopping sea, certainly 15 to 20 feet high, there you would have the curious phenomena of the waves lopping up by her sides, and some spray would come on board; but as you have some 40 feet of deck for it to fall upon and tumble off again, I do not think it would do much harm. I am under the impression that she would weather that with at least as much ease as the "Devastation." If we do not fear to go sea in the "Devastation," which simply plunges her whole body under water with no extra buoyancy but what will just serve to carry her turrets above water, nothing to speak of in the way of extra buoyancy, and all her weights high up—if we are not afraid of her I do not think we need be afraid of this ship. Mr. Scott Russell has asked me to describe why I prefer this form to the circular. The circular form I have recognised as being a very beautiful form for some purposes, but I think that Mr. Scott

Russell must have thought that his teaching was thrown away upon me altogether the many years I have had the pleasure of listening to him, if I did not understand that water has a very peculiar property when a body is passing through it; that while that body driven against it at a certain speed can divide it at a certain speed, the water has no force other than its own gravity to bring it together again, and consequently, he and every other naval architect have fined their lines aft, and properly so. We sailors call it a fine run, because the water having been divided tends to come together again to its normal place of rest near the stern. I therefore prefer this shape, and also for another reason. If I were to make a circular vessel, I should have one which would have no inclination to steer at all. The "Popoffkas" just do steer, but if they get into a 3-knot current, they are utterly unsteerable; they turn round and round in the nicest way possible, and as they are propelled by screws right at the stern, they have a nasty inclination after they have headed one way to keep going that way in defiance of anything you can do again. If you have a perfectly circular vessel all your lines are equal fore and aft and athwart ships, and she has an inclination to librate, and the only thing that corrects that tendency to libration in this vessel is her length. I think the "Thunderer" accident is sufficiently recent for us all to remember, that had that ship been in action with but one turret that one accident would have destroyed her whole fighting power. We cannot be too careful how we concentrate the whole work of a ship of many thousand tons into one turret, or one battery, or one anything. We ought to duplicate it. We should go even further if we could, but I have gone as far as I could with as little damage as I could. By adopting the revolving system I have done away with the difficulty of firing all round. It does not matter what the enemy does, I can always fire twice as many guns at him as he can at me, and if an accident occurs in one battery the other is still available—I do not say I can devise a vessel to which no accident from shot or shell can possibly occur—a shot or shell may enter either of these batteries in the course of a long fight, and if it does so there will be a certain amount of loss of life or accident of some kind. Against that I do not suppose we who go on board ships prepared for war ever expect to be guaranteed. With regard to the turbine in dirty water, the Chairman has so perfectly answered a large portion of the question, that I should naturally say nothing more about it; but I beg Mr. Scott Russell to remark that it is the most difficult thing in the world to clear a screw, even if you have a common rope wrapped round it. Of course dirty water does not affect an aperture of 20 inches wide, which would be the smallest of the apertures used here; but with wreck and sails, and so forth, the instant you find anything has happened to any one of these nozzles you have only to reverse your pump and drive it off; there is no difficulty whatever in that. I say distinctly in my paper that I have carefully calculated out the surface area under water, which amounts to 66,000 feet, and I have taken also carefully the work done by these vessels in proportion to their indicated horse-power, and their wetted surface. I believe, therefore, that on the effect of wetted surface there is but one calculation further to be made, that is, the roughness of that surface, just in proportion as the bottom gets fouled with barnacles, or as it is fresh from the builder's yard. I cannot calculate barnacles; they may get on, and I cannot say how much they will get on, but I can give you the same results as would be obtained with any other ship, and I say that the power is here exactly proportioned to give you more than the power than has been given to any other ship to drive her, so that as regards the area of wetted surface I think I ought to be held blameless. Now, with regard to the midship section, there comes in another condition, which is that of the fineness of the lines, and here I have done the utmost I could with the tonnage, giving you the greatest containing body with the least useless resisting surface; and also I intended to point out that there should be here a great deal less resistance with no rudder, keel, deadwood, or screw, or sternpost. If you take an ordinary ship the water must necessarily pass along the floor, and acquire that sort of adhesion which Sir William Thompson finds affects his instruments for measuring speed so much, due to the vessel passing through the water, and that adds proportionately to the difficulty of the escape of that water afterwards. Here we have no such fault; there is no middle body at all; the whole form is one of entrance and run and is eminently calculated for strength, which it is not where you get fine hollow lines forward

and aft going out into straight lines between the two. With regard to the platform, this ship will give a rapidity of fire of the whole of the guns which has never before been obtained. A gun to be fired every half minute must have no time expended in loading, but by this device of the revolving platform, you get that result. If you have two guns in a single turret you bring them round, fire them, and then you turn them round or incline them downwards to the hydraulic loading apparatus, and in three minutes they are ready to fire again; but during three minutes no shot has proceeded from that ship. Here, every half minute two guns are fired, and you may increase that if you like. Then, as to the guns in the "Popoffkas" being exposed to shrapnel, they are simply barbette guns, not in pits sunk down. These are no more exposed than Colonel Moncrieff's gun would be in a battery, and we all quite accept the fact that the guns on the Moncrieff principle are wonderfully well protected against every kind of fire. They tried one whole day at Shoeburyness at a known distance to plant one shell in these gun-pits, and totally failed. That is sufficient to show the probability of hitting exposed guns, but these guns are not necessarily exposed. If you have to encounter a shrapnel fire, the covers of the gun-pits are plated with 2 or 3-inch armour, and can be lowered down flat on the gun-pits; then the gun rises from below, opens shutters in the raised deck, fires, and comes down again through the shutters. That is Colonel Moncrieff's system, and that would be available in all cases where you expect to be exposed to anything like accurate shrapnel fire. If it is simply the ordinary chances of fire, I should not say it was worth while considering. What I have said as to the buoyancy of the vessel meets, I think, entirely the question of swamping. There is no swamping possible of a vessel that always has buoyancy enough to rise to the sea. She does not swamp, she lifts to the sea. If you get a spray over her, the gun-pits are fitted round in all ordinary weather with sashes, which are replaced in heavy weather with deadlights to any extent desired: the ship is therefore perfectly impermeable to water in the ordinary way. With reference to the capsizing of the "Captain," it occurred in this way. She was a vessel with very low freeboard; her turrets were high above her decks; she had tripod masts and sails; those sails were braced up to a very sharp angle indeed, and the result was, when a breeze came the whole of the effort of the sails was felt suddenly, and under those conditions the possible heel is double that due to the weight which inclines, and the vessel heeled over, having no spare buoyancy to deal with, until her side was under water. Her safe angle of inclination when she was loaded was 14°, and when she heeled a little over 14°, she went over altogether. The turrets dropped clean out, and she went down bottom upwards. I think I have answered all the questions and have nothing further to add, except to express the hope that this will be further studied by the Institution as a subject worthy of some degree of enquiry.

The CHAIRMAN: I am sure I only express the opinion of every one present in offering our thanks to Admiral Selwyn for the very interesting paper he has read. I should be sorry to express any decided opinion with regard to the merits of this new ship as a whole. With regard to the form of the vessel, I have always disliked straight lines, and to that extent, I think, I will go with Admiral Selwyn; we have very fast vessels, entirely owing, as I believe, to the absence of straight lines. With regard to the revolving platform within a circular battery, Admiral Ryder and myself, in a report made in 1871, advocated barbette guns, raised up and down by hydraulic power; I therefore naturally approve of circular batteries with a revolving platform, and for many reasons which I had not time to express. The objection raised to these circular fixed batteries has been rather aggravated with reference to exposure to plunging fire. No doubt, if a ship rolls over, you are likely to have a good many killed, and perhaps the gun disabled.

Admiral SELWYN: It is completely covered with two or three inches of iron.

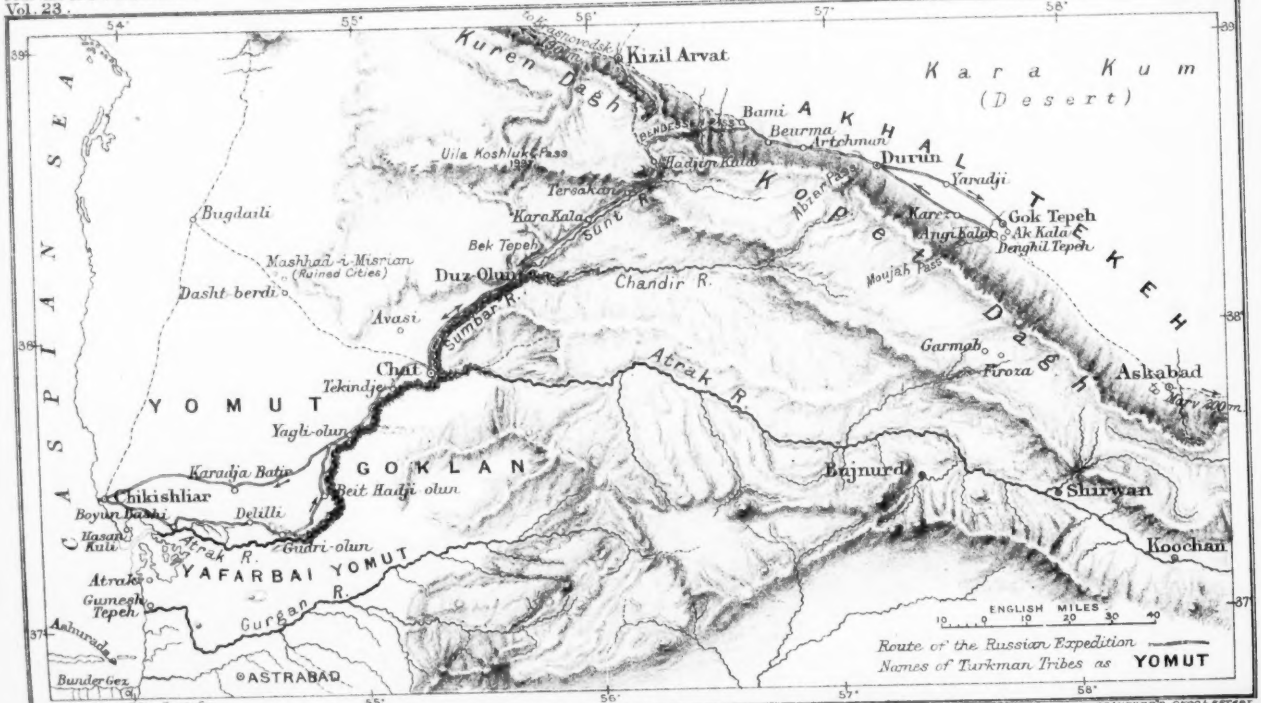
The CHAIRMAN: That should be sufficient to glance off almost all shot; and as this vessel would naturally be a steady one, she would not heel over much to receive a shot at a very great angle. The point upon which I will offer a few remarks is my favourite hobby, the hydraulic propeller. It may be very interesting for me to state what is totally unknown, perhaps, as to the latest position of that propeller. The "Waterwitch," the "Vixen," and the "Driver," the three gunboats which were built, have been pronounced by Mr. Reed himself as the very worst character of vessel in

every form that could possibly have been built. He said he was obliged to build them, and I believe he was driven into building an armour-plated gunboat of a certain size. No doubt they are the greatest beasts ever put into the water; in fact, they are perfectly unseaworthy, and they have not been able to go to sea but once; that is to say, the "Waterwitch" tried to go from Portsmouth to Plymouth, and she very nearly went over; the "Vixen" tried to get from Plymouth to Ireland, and was very nearly lost. Two of the ships were afterwards lightened and convoyed outside the reefs at Bermuda, where they are at present; the other vessel laid at Plymouth Sound until I called her to Portsmouth with a view of making a few experiments—no experiments having been made, and the hydraulic propeller never having been tested as to its going against other vessels in a sea-way, when the other vessels would have their screws out of water, and the hydraulic her whole power exerted. The result was, when she was rolling 45°, the turbine was working as steadily as if she had been in still water; there was no pitching affecting the propelling power. With regard to the gunboats lately built for China, with very light draught of water, I was told by the Commanding Officer of the steamer who brought them round, that even in a fresh easterly wind on the coast they could not steer at all, that directly they tried to turn their bow to the sea the twin-screws were out of the water, and they lost headway and fell off again, and if the wind had come up at all strong they must have gone ashore. There is an effort also made in these gunboats to drive them both ways, and they do get four or five knots astern; but at the same time it is certainly a very extraordinary thing to try and drive a ship by forcing the water against the ship, for when you reverse the screws you are driving the water upon the ship, and thereby impeding her going astern. It is all well enough in the torpedo boats, where the screw is a long way from the vessel and of great diameter, there they do stop the boat as quickly as the hydraulic. But you can never build a ship and put the screw in that way, and therefore with the great momentum of a ship, I do not think you will ever be able to stop her by reversing the engines with the screw, at any rate, not under a considerable distance; and if the wind is aft and blowing at all strong I do not think you would ever stop her with the screw. I tried it in the "James Watt," and I could not. The danger of using the screw in going astern is very great, because you cannot tell which way your bow will go. It depends on whether it is a right or a left-handed screw, it may go exactly the wrong way. I consider stopping a ship is one of the most valuable features of fighting efficiency, for if two fleets engage each other and the vessels are enveloped in smoke—a thing that is never sufficiently considered—if you are going ahead to try and ram, and miss your object, you may find yourself running into one of your own ships. I believe we are just as likely to be running into our own ships in a scrimmage of that kind as into the enemy, therefore ships will be very chary of going at any speed to attempt to ram, because if they miss their object and find themselves with one of their own friends near them, they cannot stop, and the chances are many accidents will occur in that way. With the hydraulic propeller you can stop a ship. You can make certain of so doing without any injury to the engines, you have nothing to do but to turn the water by a bar tap, as proposed by the late Captain Coles. He suggested the addition of a cock inside the discharge-pipe, by which you can in a moment turn the whole power of the engines to go astern to such an extent that it almost takes you off your legs. In that way you get the whole power at once to stop your ship. I therefore consider that the value of the hydraulic has not been sufficiently considered. As to its present position with regard to speed, all we know is that it has only been tried so far, and so far it cannot be denied that it has proved itself equal to the screw. In the last experiment I made at Portsmouth, by doing away with the canal and letting the water come straight up from below, we gained half a knot of speed. It was not my doing, but it was done by the Officers of the Admiralty, who tried the vessel before and after the alteration was made. They went even to the trouble of cleaning her bottom, and took her to the mile, and they found that the alteration gave half a knot extra speed. That half a knot of extra speed at once did away with everything that had ever been said with regard to the loss of speed between the "Waterwitch," the "Vixen," and the "Driver"—in fact, it gave her an advantage, so that by the Admiralty figures the "Waterwitch" has so far proved the hydraulic

to give an equal speed to the screw. I have a right, I think, therefore, to say that so far the hydraulic has proved a success. They acknowledge it; but still, somehow or other, there is a sort of love for the screw propeller, and they will not alter it; the screw propeller is the most dangerous propeller in the world. You cannot stop your ship with it. It is like running your railway trains without a brake. If every vessel meeting at sea could stop in its own length you would have very few collisions: but on you must go with the screw, and if you put your helm the wrong way an accident occurs. Then, again, you do not foul with the hydraulic, which is an enormous advantage. As I described just now, if the hole that lets the water in is not bigger than the nozzle at the discharge pipe, whatever comes in must go out. Then, again, for ramming, the hydraulic gives you a double ram. Instead of having to turn her she has only to go astern, perhaps into another enemy's ship. I cannot understand how it is that for our fighting ships we can ignore those two points—stopping a ship and being able to ram both ways; because I am quite sure that with the screw, whatever you may do, you will never get a vessel to go astern, and, besides, your screw is in a dangerous position. Then, if you want to ram both ways by the hydraulic propeller, one at each end of the ship, you have nothing to do but to use them as you like, and you can twist your ship round from the extreme end with a small turbine at each end of the ship, so that you can steer, not by the central pump, but by a pump placed for the purpose.

Captain CURTIS: Would she turn on her own axis?

The CHAIRMAN: On her own axis. One remark that has not been noticed with regard to Admiral Selwyn's ship is this. If you notice two rams, bow to bow, in a dockyard, and imagine that they do not strike stem to stem, but are running on to each other bow and bow, if the spur takes the bow, and gets in anywhere at the bow, it will rip the whole side of that vessel out under water under the armour plating. It must do so; it would not make a hole, but it would regularly tear it right out or break off, one of the two. If it is strong enough it will not break off, but will make an enormous chasm in the side of the vessel. Whereas, in a vessel shaped in the way Admiral Selwyn proposes, the water-line would keep the other vessel sufficiently off to prevent the spur from striking her under water, as heavily at any rate as a vessel shaped in the ordinary way. I think I may now ask you to join me in tendering a vote of thanks to Admiral Selwyn for his very interesting paper.


Kizil Arvat
Kara Kum
(Desert)
Kuren Dagh
Bami
Beurma
Artchman
Durun
Yaradji
Uila Koshluk Pass
Hadjim Kuli
Tersakan R.
Kara Kala
Sunt R.
Bek Tepeh
Duz-Olum
Chandir R.
Bugdaili
Mashhad-i-Misrian
(Ruined Cities)
Dasht berdi
Avasi
Sumbar R.
Chat
Tekindje
YOMUT
Yagli-olum
Karadja Batir
GOKLAN
Beit Hadji olum
Chikishliar
Boyun Bashi
Delilli
Hasan Kuli
Atrak R.
Gudri-olum
YAFARBAI YOMUT
Atrak
Gumesh Tepeh
Gurgan R.
Ashurada
Bunder Gez
ASTRABAD
CASPIAN SEA
Kara Kala
Ak Kala
Yangi Kala
Gok Tepeh
Benghil Tepeh
Moujah Pass
Garmab
Firoza
Askabad
Bajnurd
Shirwan
Koochan
ENGLISH MILES
Route of the Russian Expedition
Names of Turkman Tribes as YOMUT
Russian Versts, 3 Versts = 2 Eng. Miles
STANFORD'S GEOG.L ESTABT

LECTURE.

Friday, December 19, 1879.

MAJOR-GENERAL SIR FREDERIC J. GOLDSMID, K.C.S.I., C.B., Member of Council, in the Chair.

THE TEKKEH EXPEDITION OF 1879.[1]

By E. DELMAR MORGAN.

THE Tekkeh Expedition is another in the already long list of steppe campaigns undertaken by Russia in Central Asia, fought not so much against the powers of man as against the forces of Nature. Distant marches across arid plains, difficulties of transport, and an enemy who like the wild animal of the neighbouring desert appears only to vanish again in misty distance, now hanging on the flanks of the advancing columns, cutting off stragglers, or falling upon long trains of supplies and retreating again to mountain fastnesses secure from pursuit, are conditions of steppe warfare, and Russian soldiers are well accustomed to them.

Improvements in modern military science, rifled artillery, mountain guns, and breech-loading rifles have done much to assist Europeans against Asiatics, and to counterbalance disparity of numbers. Were it not for these powerful aids it would doubtless have fared badly with Russia in some of her engagements with the natives, for distances are

[1] The subsequent narrative is, for the most part, taken from Russian sources, viz., the war correspondence in the *Golos, Novoye Vrêma*, and *Moskofski Védomosti*. The description of the action of Denghil-tepeh, and subsequent retreat, is from the last of those journals. The *Daily News'* correspondent's letters from the east coast of the Caspian have also been consulted, as well as the following works: Mouravieff's "Travels in Turkomania;" "Russian Military Despatches from "Central Asia (published edition);" Colonel Stebnitzky's article on Turkomania in the Journal of the Caucasus Section of the Imperial Geographical Society; Major the Honourable G. C. Napier's article in Journal Royal Geographical Society, vol. xlvi; and Journals and Proceedings Royal Geographical Society.

The woodcut of the action is from an engraving in the *Moskofski Védomosti*. If not strictly accurate, it will, at all events, assist the reader in following the letterpress. The map has been prepared by Mr. Bolton from all available sources, Russian and English, the cartography of this region having recently received important additions by the surveys of Stebnitzky, Markosoff, and other Russian Staff Officers. The dates are all old style.—E. D. M.

as great as ever, and the means of crossing them are no better than they were when Peter the Great's expeditions against Khiva failed, 160 years ago, and when Perofsky turned back his wasted battalions to Orenburg in 1839. These repeated failures might have daunted a less resolute and presevering Power than Russia, and convinced her that with the means at her disposal it was futile to contend against the apparently insurmountable barriers Nature had placed in the way, for the fertile oases of Central Asia are like islands in oceans of sand. With the gradual spread of her empire in Siberia however, and the extension of her influence south of the Caucasus, the position of Russia grew stronger, whilst the powers of resistance of the States of Central Asia became weaker, and during the last fifteen or sixteen years the march of events has been rapid. Adv ancing simultaneously along two lines from east and west no difficulty seemed insurmountable, no opposition too great to delay the victorious progress of her troops. Orenburg, formerly a frontier fortress to overawe disorderly Kirghiz hordes, was left a thousand miles behind, and at length Samarkand, the famed capital of Tamerlane, glittered in the Imperial diadem of the White Czar.

Before the storming of the Kokandian Fort of Ak-Mechet, on the 28th July, 1853, there was only one Russian fort on the Syr-Daria or Jaxartes. That same year three more were erected, named respectively Forts 1, 2, and 3, and Ak-Mechet, under its new name of Perofsky, became the chief Russian stronghold on the Syr. The Kokandians, however, did not give way at once; assembling under their leader Yakub-Khan, afterwards Ameer of Kashgar, they assumed the offensive and besieged the Russian garrisons. Discipline and modern artillery, however, at last gained the day against superior numbers, and the Kokandian Army was finally routed, abandoning its camp, standards, 17 guns, and a large quantity of gunpowder. This occurred towards the close of 1853. During the following years 1854 to 1861 active hostilities were suspended on either side. Russia's hands were full in Europe, and she could not spare troops for the conquest of Asia. On the other hand, the Kokandians, taught by past experience, attempted nothing more than desultory raids and skirmishes with outlying pickets. In 1861 Fort Djulek was built on the Syr, and in the winter of that year the Kokandian fort of Yani-Kurgan was taken and destroyed. From about this time the tide of success was almost unchecked, fort after fort fell into Russian hands, the line of the Chu was united with that of the Syr, and a new and advanced frontier laid down. Seeing the hopelessness of resistance the natives submitted to their fate. Town after town opened its gates to the Russian Generals. On the 14th and 15th June, 1865, Tashkend, a city with about 200,000 inhabitants, and a circuit of 16 miles, was stormed by a small force under General Chernaieff, though the garrison numbered 15,000 regular troops, and the defenders were 30,000 altogether. The fall of this important place established Russian supremacy in Central Asia on a firm basis, and led the way to the downfall of the neighbouring Khanat of Bokhara. Had these States combined against the common enemy results might have been different;

but owing to internal dissensions there was no unity between them, and by fighting one after the other singly, Russia's task was comparatively an easy one. But these successes were also due to the bravery and discipline of the Russian soldiers, for on several occasions the fortunes of war in these remote countries hung on a thread, and were only saved by the presence of mind and intrepidity of Officers and men. At Uzun-Agatch, on the 20th October, 1860, Colonel, now General, Kolpakoffsky, with every available man, including the garrisons in the Semi-retchinsk district, was completely surrounded by Kokandians and their Kirghiz allies in the valley of the Kastek. For nine consecutive hours they repulsed the attacks of an enemy twenty times as numerous as themselves, and advantageously posted. This action decided the Kirghiz tribes in the valley of the Chu, hitherto wavering, to side with Russia. Again, in the summer of 1868, after the capture of Samarkand, when General Kaufmann had gone in pursuit of the Bokharian forces, leaving a garrison in the Citadel, the population rose against the Russians, and, uniting with inhabitants of other towns and a horde of Kipchaks, besieged the garrison. For seven days these gallant men, numbering barely 600, defended the Citadel and repulsed the repeated attacks of their enraged, fanatic enemies. Sick and wounded were brought out of hospital, laid on the walls, propped up with cushions, and rifles put into their hands. So sudden and fierce was the onslaught that a survivor told me that his morning cup of tea remained untasted from the moment the alarm was given to the seventh day, when Kaufmann returned in time to rescue them from their critical position.

In her wars with Kokand and Bokhara, Russia could always count upon the co-operation of the Sarts, who form the mercantile class in all the cities of Central Asia. They had long suffered from the cruel oppression and exactions of despotic Khans, and were naturally inclined to side with a Power which promised to restore trade and relieve them of such intolerable burdens, and so unjust a rule.

A third and yet more isolated State had to be conquered. Khiva, cut off from the rest of the world by vast sandy tracts, had long defied the Russian arms. Mission after mission had been sent there, military expeditions had attempted to subdue it, but all in vain. Relying on deserts, impassable in winter or summer to troops encumbered with baggage and war material, this Khanat, last home of the faithful in Central Asia, continued to imprison subjects of Russia, plunder her trade caravans, and excite hostility among her Mahommedan dependants. Orders were accordingly given in 1873 to subjugate Khiva.[1] Marching from three sides across plains so arid that the failure of water at a single well threatened destruction to Kaufmann's force, the three columns met in the oasis, and after a brief struggle the Khan was reduced to vassalage, and Russian power was ascendant on the Lower Oxus.

A still more difficult task remained for her. By the conquest of Khiva, Russia was brought into closer relations with the Turkomans,

[1] For account of this campaign, see Journal, vol. xviii, No. 77, p. 212, *et seq.*—Ed.

a wild race of people roaming over the vast plains to the east of the Caspian, and numbering about a million of souls: they all trace their descent from one common Turkish stock, yet are divided into numerous tribes between whom no bond of union or fellowship exists. Like the Indians of North America, they preyed on one another when not engaged in raiding Persia, or disposing of their captives in the slave marts of Central Asia. They obeyed no sovereign, recognised no law but that might is right. Though professedly Mahommedans of the Sunni sect, unlike other Moslems, they were lax in religious observances, treating their mollahs with little respect and having no mosque or minaret in their settlements. Skilful horsemen, brave warriors, they were arrant rogues and thieves, destitute of mercy to the vanquished and of hospitality towards the stranger. Their houses were felt tents, their horses the most precious of their possessions, their homes were the boundless desert, the rocky mountains, and the grassy plains; assembling in their favourite haunts they would choose some khan, or leader, whom they would follow to the "alaman" or raid. Then, mounted on fleet steeds, they would swoop down upon the defenceless towns of Khorassan, and return laden with plunder to their winter quarters at the foot of Elbruz. A recent Russian writer has given the following description of one of these raids :—"The khan intending to make the raid drives his lance into "the ground in front of his felt tent with a bundle of burning flax at "the end of it. This is the signal, and those desirous of joining drive "their lances into the ground by the side of the chief's. Every day "the khan counts them. News of the intended raid spreads like "wildfire through the oasis, gossipmongers carry it from tent to tent, "loudly proclaiming the name of the chief and inviting others to try "their luck. When there are enough lances the chief usually gives a "month to prepare and bids them rendezvous on a certain day. But "his authority only lasts for this particular occasion, and is limited "to the participators in the 'alaman.' These too are on an equal "footing as regards one another, sharing in the plunder and reserving "to themselves the right of returning whenever they please. The "chief usually preferred in this kind of warfare must be experienced, "he must know the country well, and be able to show his followers "a secure hiding place if hard pressed by their pursuers. This is "the kind of authority exercised by Nur-Verdi-Khan and others."

The most important Turkoman tribes are the Yomuds, the Goklans, and the Tekkehs. The first of these are the most numerous, and being the westernmost were the first to come under Russian influence. During the last ten years expeditions have crossed and recrossed their steppes and camping grounds. Their piratical dealings along the east coast of the Caspian have been stopped and their raids into Persia checked. The Goklans occupy the fertile lands on both banks of the Hurgen, and between this river and the Attrek, and are more or less subject to Persia. Both these tribes are subdivided into numerous clans, and have been visited during the present century by European travellers such as Baron Bode, de Gobineau, and others.

The third and most warlike of Turkoman tribes are the Tekkehs.

Owing to the remoteness of their country little was known of them. They were said to number 40,000 tents distributed along the foot of a range of mountains, which under the names of Kurren-tagh, or Kopet-tagh, extends from the Persian Elbruz, south of Merv, in a north-westerly direction, for 360 miles, nearly to the Caspian. At the foot of this range is a narrow strip of fertile land from four to fifteen miles wide, watered by streams which descend from the mountains and are lost in the sands beyond. This is the so-called Tekkeh Oasis. To the north and east it is separated from Khiva and the Oxus by the Kara-Kum, or "Black Desert;" to the south it is sheltered by the mountains, whilst on the west 150 miles of desert separate it from the Caspian. Through it lies the route to Sarakh and to Merv. Khiva is six days' ride across the desert for well mounted horsemen. This was, according to Rawlinson, the ancient kingdom of Parthia. Here were bred the horses which drew the chariot of Darius. From the Parthian Dahæ it derived its ancient name of Dehistan, and afterwards as a sort of "debatable land" between Iran and Turan, now acknowledged the supremacy of Persia, now formed part of ancient Kharezm. But in more recent times, as Persia grew weaker and the Khans of Khiva became the contemptible despots of the present day, its inhabitants grew bolder and their marauding raids into Persia more frequent and desolating.

Shah Abbas, surnamed the Great, settled colonies of Kurds in Darchgaz, to the north of the mountains, in order to check their raids, cutting the country into halves, that on the west being inhabited by the Akhal Tekkehs, whilst on the east are those of Merv, and to this day Kurds under the leadership of their khans invade the Tekkehs' country in order to punish them for their depredations. When the Tekkehs retire into one of their forts, the Kurds having no artillery remain a few days near the fort, and finding it impossible to take it with such arms as they possess, are obliged to return. Of late years Kaider Khan of Budjnur attacked Kizil-Arvat, with his Kurds. In 1813, Mahommed Rahim, Khan of Khiva, completely subjugated the Tekkehs for refusing to assist him in making war upon Persia, and drove them into the mountains, carrying numbers of them to Khiva. His successors, not less cruel though more incapable, relaxed their hold on these turbulent subjects, who, returning to their favourite haunts, renewed their depredations, and for the last fifty years have been the terror and scourge of Northern Persia.

Against this people Russia decided on sending an expedition in 1879. The *Invalide Russe* in a brief summary introduces the subject in the following way:—"This year, following the precedent of the "last ten years, the Trans-Caspian military forces, strengthened by "contingents from the Army of the Caucasus, were ordered to invade "the Akhal-Tekkeh country. The object of this expedition, as of all "those previous, is to introduce order into the Trans-Caspian steppe, "and protect the trade route between Krasnovodsk and Khiva." Public opinion in Russia, however, was indifferent or hostile to the expedition, so uncertain were its objects and so costly the preparations made for it. At last official reserve gave way, and Captain Kuro-

patkin, of Kashgar celebrity, in the October number of the military magazine, after a descriptive sketch of Turkomania and the Turkomans, proceeded to state the objects of invading the Tekkeh country. It was, in short, to punish the Tekkehs and to put a stop to their attacks on Yomuds subject to Russia.

Preparations indeed on an extensive scale had been made. The troops selected for this purpose were mostly drawn from the Army of the Caucasus, and had been seasoned in a hard campaign against the Turks. They were some of the finest soldiers in the Russian Army, and their Commander-in-Chief had particularly distinguished himself in Asia Minor. The career of General Lazareff deserves more than passing mention. An Armenian by birth, with no education but what he acquired in active military life in the Caucasus, he entered the Army as a common soldier, where he soon attracted attention by his coolness and courage in the field. He was before long promoted to the rank of Officer, and on the outbreak of the last Russo-Turkish War rose to the rank of Lieutenant-General. After the Russian defeat at Kizil-tepeh, Lazareff was promoted to be Major-General, and was given the command of the left wing of the Army under General Loris Melikoff. In this capacity he defeated Mukhtar Pasha, and turning the Turkish position by a skilful flank movement, routed their forces on the Orlok heights, and succeeded in cutting off the retreat of their right wing upon Kars. He led the assault on this fortress on the 6th of November, and by his personal courage and example contributed greatly to its success. On being appointed to the command of the Tekkeh expedition he at once set about organizing his force with characteristic energy and resolution. His tall figure, Herculean frame, penetrating glance, and peculiarly deep voice, inspired the Turkomans with dread. Learning of hostilities preparing by Tekkehs, he wrote to their chief counselling submission and warning them of the consequences of disobedience. Death alone prevented him from keeping his word.

There are two routes from the Caspian to the Tekkeh Oasis. The more northerly starts from Krasnovodsk—the most convenient landing-place on the east coast of the Caspian, passes north of Balkhan Bay and crosses the Usboi or old Oxus channel between the Great and Little Balkhans, striking the Kurren-tagh at Kizil-Arvat, the first Tekkeh fort on the north-west. By this route it is 220 miles from the Caspian to the Tekkeh country, or 140 (divided into nine stages) from Mollah-Kari, to which there is communication by water. The road is practicable throughout for light ordnance, but food and water are scarce; and it was probably on this account, and also doubtless in expectation of obtaining supplies from the rich districts round Astrabad, that the more southerly route from Chikishliar up the Attrek was preferred.

Chikishliar, the selected base of the Russian expedition, is a dreary spot on the south-eastern coast of the Caspian. Its flat shores render the work of landing troops and materials both tedious and difficult. Caspian steamers with an 8 feet draught, owing to the extreme shallowness, cannot approach within 3 or 4 miles, and have to dis-

charge their freight into Turkoman boats, and these are towed ashore. To obviate this difficulty, a jetty was constructed and a tramway laid down, but even then with a rough sea the work was interrupted for days; and it occasionally happened that men who had had a fine passage across the Caspian were kept rocking for days at anchor off the coast. By the end of June, however, men and horses were all landed, and Chikishliar presented a busy aspect. It might have been mistaken for a seaport with its piles of merchandise, such was the activity displayed in landing stores and preparing for the advance.

A month passed and everyone anxiously awaited the order to march. But means of transport were still inadequate, and General Lazareff decided not to move the bulk of his force until two months' supplies were accumulated at Chatte, a strategical position at the fork of the Attrek and its chief tributary, the Sumbar.

The question of transport was of the utmost importance, and taxed the energy of the Commander and the resources of the country. Vast numbers of camels had been supplied by friendly Turkoman tribes, 1,500 arabas, or two-wheeled carts, and mules had been brought by sea from Baku, and still there was not enough, for in these marches the usual allowance is one camel per man, and their daily diminution was considerable, owing to over-fatigue, improper food, and bad water.

25,000 camels are said to have perished in the campaigns in Turkomania during the last five years, and if to this be added the 40,000 stated to have fallen in the Anglo-Afghan expedition of 1878–79, the sum total of these losses must in course of time, if continued, lead to the extinction of this useful animal, besides impoverishing the country. After transport, water was a paramount consideration. To ensure a sufficiency within two days' march of Chikishliar, General Lazareff sent a force of Cossacks to destroy a dam constructed by Yomud Turkomans at a place called Bent. The water of the Attrek, however, was quite unfit for the men, and what they required had to be carried in casks on the backs of camels and replenished from wells as opportunity offered.

At last the long expected order was given, and by the end of July the Tekkeh expedition began its march, an advanced guard under Prince Dolgorouky, composed of three battalions of infantry (2,400), and 600 cavalry, having started some weeks previously. The route lay for 12 miles parallel with the sea, then up the right bank of the Attrek to Chatte, distant 100 miles from Chikishliar, over an almost barren plain, where men and horses suffered terribly from heat and thirst. Verdure, however, is observed at intervals, and the soil is capable of cultivation, traces of irrigation, fields, and ruined forts indicating a previous state of prosperity. The Attrek in summer scarcely deserves the name of a river, shrinking to a small muddy stream between high, steep banks of clay, and imparting no moisture to the adjacent country, except at flood time. Before reaching the sea it is absorbed in extensive marshes thickly grown with reeds, and swarming with game of all kinds. Politically, the Attrek is important, as being the boundary between Persia and Russia, but the insignificance of its stream, and the ease with which it can be diverted into new channels by the

Turkomans camping near its mouth, cause it to be a somewhat indefinite boundary. Thus the Persians claim the whole of Hassan-Kuli Bay, into which it trickles, while Russia denies their right to the northern half. An amusing incident lately arose out of these conflicting territorial claims. Whilst the Russian force was encamped at Chikishliar, news was brought that a Persian Officer, Asker Khan by name, had made his appearance at Hassan-Kuli (a large village on the bay of the same name, a few miles south of Chikishliar), and announced that he had been sent by his government to erect a fortress there. Orders were at once despatched from Russian head-quarters desiring him to withdraw, or to show his credentials. This, however, Asker-Khan declined doing, and stated moreover, that since he was on Persian territory he would not obey Russian orders, and he continued his survey. Hereupon a pressing invitation came from General Lazareff to visit him. He accordingly proceeded to the Russian camp, where he reiterated his former statement, that Hassan-Kuli belonged to Persia. Maps were produced, Russian and English, and every argument used to prove him in the wrong. Asker Khan, however, was not at all convinced, though he parted with General Lazareff on good terms, and turned homewards.

Persia is indeed placed in a dilemma. Too weak herself to control the warlike tribes on her frontier, she derives a certain advantage from these operations of Russia in the security afforded to the peaceful inhabitants of her northern provinces. On the other hand, as an independent State, she can protest against any violation of her territorial rights. But if unsupported by any European Power, and left to deal with Russia alone, she must of course succumb, and like other weak Asiatic States become absorbed in the stronger Power.

Early in August, the force about to operate against the Tekkehs was echeloned along the Attrek, and its right affluent the Sumbar, between Chikishliar and Tersokan, at the foot of the Kurren-tagh, strong detachments holding Chatte and Duz-Olum. The advance guard under Prince Dolgorouky had occupied Bendessen Pass, having had a skirmish with Tekkeh horsemen, and captured a herd of cattle from one of the villages. So far, no serious resistance had been encountered, and the way to the oasis lay open. But a serious disaster now overtook the expedition in the death of their chief. General Lazareff had fallen a victim to a carbuncle, a complaint which appears to have been not uncommon at Chikishliar, especially among Officers. Though weak from the effects of a surgical operation, and against the advice of his doctors, he insisted upon starting to join his troops, whose departure had been unavoidably delayed beyond the date he had fixed. On arriving at Chatte he had to be lifted out of his carriage, and laid in a kebitka (felt tent). Summoning the doctor, he asked what was the matter with him. "Your Excellency must not continue the journey," was the answer. "I did not send for you to tell me that," exclaimed the veteran, and he gave orders that everything should be ready to continue the journey on the morrow. The morrow, however, never dawned for him, that same night he became delirious and died on the 14th April. Upon the death of General Lazareff, the command de-

volved by seniority on General Lomakin, an officer well versed in steppe campaigns.

His first act was to concentrate his force at Bendessen, his next to summon a council of war, at which it was decided to push forward two columns into the enemy's country as originally planned, leaving a battalion of the Shirvan regiment and a body of Turkoman Militia at the pass to guard the waggons, prevented from going further by the state of the roads.

The two columns about to enter the Tekkeh country numbered altogether about 3,000 men, the losses from sickness having been very heavy. Fifteen days' rations, ammunition, and whatever was absolutely necessary were carried on camels, all superfluous baggage being left behind at Bendessen, in order to take as few encumbrances as possible. The advance column, commanded by Prince Dolgorouky, and consisting of two battalions of the Kurinian and Kabardinian regiments, a battalion of tirailleurs, some dragoons, a sotnia of Volga Cossacks, and two sotnias of Daghestan irregulars, with four field and four mountain guns, started from Bendessen on the 22nd of August (old style). Descending the pass, not without considerable difficulty, they reached Bami, a Tekkeh fort in the oasis, on the following day passing through Beurma. On the 24th they continued the march through Artchman, Suntchi, Murza, and Baharzek, halting at Durun for the second column to join them.

This column was commanded by Major-General Count Borch, and comprised three battalions (of the Erivan, Grusinian, and Shirvan regiments), three sotnias of Cossacks, and four field guns. It left Bendessen on the 23rd and reached Durun on the 26th August. During the whole of this march, 55 miles long, the enemy did not appear, all his settlements were deserted except by the infirm and weak, every able-bodied Tekkeh having gone to join the defenders at Geok-tepeh, where masses of them were reported to be congregated. The country astonished the Russians by its fertility; "Here," the soldiers exclaimed, "one can live." It seemed to them a land flowing with milk and honey after the privations they had gone through. The harvest had been mostly gathered, and stores of corn, left behind by the inhabitants in their hurried flight, fell into the invaders' hands. Melons and grapes abounded, and together with clear mountain water, formed a refreshing change in diet and took away any lingering scorbutic symptoms.

But the silence of the deserted villages was ominous, and some of the Russians, on entering the region as yet untrodden by European, recalled to mind the words of Tekmes serdar, a Tekkeh chief, who had consented to mediate between them and his own tribe. Returning from his unsuccessful mission, he warned General Lazareff thus:—"Our people are abandoning their homes and mustering in their "strongholds, where they wait to destroy you."

At Durun, a small body of Tekkeh horse appeared, but after exchanging shots with the cavalry patrols speedily vanished. On the 27th August the whole Russian force halted at Nukhur, and concentrated at 3 P.M. of the same day at Yaradji, after a march of 15 miles.

passing the deserted villages of Karagan, Ak-tepeh, Yangi-kala, and Melim, without seeing or being molested by the enemy. At dawn on the 28th the march was continued. The cavalry of the advance guard, under Dolgorouky, set out from Yaradji at 2 o'clock and overtook the infantry, who had bivouacked there the evening before. After a short address from General Lomakin, who called upon them to do their duty as brave men and good soldiers, the march commenced in the following order:—The infantry and artillery formed the first line, preceded by skirmishers, next followed a rocket battery between two squadrons of dragoons, and the division of irregular horse brought up the rear; the flanks and rear were further protected by mounted skirmishers. In this order the column advanced slowly over the plain, enlivening its march with songs, invariable accompaniments of Daghestanis. On their right hand rose the Kopet-tagh range, their constant companion since entering the oasis, and at the foot of the hills were earthen forts, called by Turkomans "Kalas," and corresponding to the Kishlaks of the Khivan oasis. At 9 o'clock in the morning, a distant hill, detached from the main range, and projecting like a bluff or headland on the sea coast, could be dimly discerned descending in terraces towards the plain. This proved to be Geok-tepeh, or Blue Hill, and the Tekkeh fortress lay at its foot. Soon afterwards the enemy's cavalry were seen advancing slowly in clouds of dust. No alteration was made in the order of march, except that a Turkoman messenger was dispatched to Count Borch with a note desiring him to hasten. The sight of the enemy they had been so long seeking produced an inspiriting effect on the Russians, and the songs were rather louder than usual as the Lesghian irregulars put spurs to their horses, and, standing up in the stirrups, executed some of their characteristic and graceful feats of horsemanship. The Tekkehs, numbering over 2,000, were soon near enough to enable the Russians to note the stride of their splendid horses; when wheeling to the left, they rode in line, several horsemen deep, along the foot of the mountains round the right flank of the Russians. A second time messengers were sent to Count Borch, and the advance guard, throwing its left shoulder forward, halted. This gave an opportunity of getting the range of the enemy, and a few rounds of grape and some rockets, fired with great precision, fell into the midst of his ranks, creating an extraordinary effect, for the Tekkehs at once hastened their speed and passed rapidly between the Russians and the hills, disappearing behind the small fort of Egman-Batyr in rear of the advance guard, and at the foot of the range.

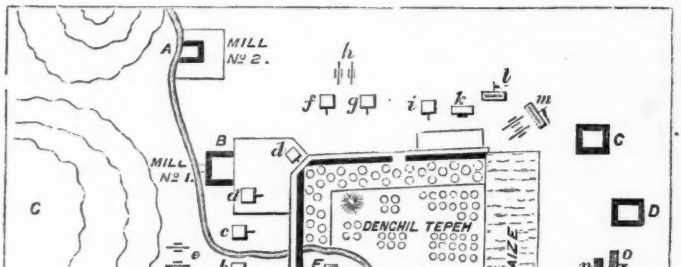
About an hour afterwards firing was heard in the direction of Yaradji. This was at first supposed to be Count Borch's signal to give notice that he had received the message and was approaching. Continuous firing, however, proved the incorrectness of these surmises, and the advance guard were soon made aware of the true position of affairs. Kara-Batyr knew of the advance of the Russians in two columns, and supposing that all their fighting men were in the first, and that the second mostly consisted of baggage animals, determined upon attacking the latter, judging that, if he were successful,

the Russians would perish without any further fighting. He, therefore, avoided an encounter with the advance guard, and rode towards Count Borch's column, which had left Yaradji two hours after the time agreed upon, and were therefore eight miles behind the advance guard. A mere handful of Cossacks and militia, under Lieutenant Samet, met the Tekkehs sword in hand, and an obstinate fight ensued, the Cossacks retiring upon their main column with the loss of eight killed, closely pursued by the enemy. But a storm of bullets and hand grenades soon stopped the pursuers. Repulsed on one side of the square, the Tekkehs assailed the other with even greater fury, and, last of all, the baggage following two-thirds of a mile behind Count Borch's column, and escorted by a covering battalion, under Captain Kegamof. Here a like fate awaited them and, disappointed in their efforts, the Tekkehs fell back, and, passing between the isolated columns, appeared about 11 o'clock on the left of the advance guard.

It was during this movement that a Cossack, dispatched with a message from the Commander-in-Chief to Count Borch, fell into the enemy's hands, and was treated in the usual barbarous way, *i.e.*, his head was cut off, the body stripped, the chest cut open, and the red shoulder-straps thrust into it. Lieutenant Alexandrofsky, sent on a like mission, nearly shared the same fate, and only escaped by turning his horse's head in time, and galloping away.

The enemy's cavalry now appeared on the left of the advance column, but kept at a respectful distance from it and in scattered parties, provoking the Russian dragoons and irregulars eager to close with them. Then suddenly, as though by magic, they dashed forwards, and before the supports had time to come to the rescue, were in the midst of the skirmishers, of whom they cut down a few, and, retreating under a shower of bullets, left some wounded behind. After this the enemy's cavalry did not again come within gunshot, and the advance guard, continuing its forward movement, halted about midday on a sandy hill within range of Geok-tepeh. Here six guns were immediately posted, and General Lomakin, with his staff, took up their position, whilst a destructive fire was poured into the Tekkeh fortress. The position of affairs, as viewed from the hill, was then as follows:—Two-thirds of a mile off, in a plain slightly inclined towards the centre, lay the almost square Tekkeh fortress of Geok, or Denghil-tepeh, enclosing in its outer wall a space of rather less than a square mile. It seemed to have none of the high walls, or bastions, usually seen on Tekkeh forts, and the space within the apparently low mud wall was crammed with kebitkas, or felt tents, looking from a distance like clusters of black bee-hives. There were said to be 12,000 of them packed in this confined space. South of the fort and a mile and a-quarter from it, rises the Kopet-tagh range, east of it is Geok-tepeh, whilst on the other sides is level plain, gradually rising towards the field of battle, so as to be commanded by it at artillery distance. From the west face of Denghil-tepeh issues the principal irrigating dyke, flowing towards the battle-field. About five or six hundred paces from this face it turns northwards and then to the north-west. On it, not far apart, stand two mills, each protected by a square

earthwork and forming outlying defences to the main position. On the north and west the plain was covered with sown corn and intersected with numerous smaller dykes and embankments. The first impression produced on the observer was one of wonder that such an insignificant fort, so badly situated topographically, should have been chosen by the Tekkehs for their grand struggle, giving, as it did, considerable advantage to an attacking force if provided with artillery.



A and B. Earthworks to cover mills.
C, D, E, and F. Forts.
G. First positions of the Russians.

Positions of Troops before the Assault.—*a*, Sappers; *b*, Kurinian battalion; *c*, Kabardinians; *d*, mixed battalion of Tirailleurs; *e*, Tersky Horse Artillery battery; *f*, Grusinian Grenadiers; *g*, Erivan Grenadiers; *h*, half battery 20th Brigade; *i*, Volunteers; *k*, rocket sotnia; *l*, half squadron of Dragoons; *m*, sotnia of Volga Cossacks with Prince Wittgenstein; *n*, half squadron of Dragoons; *o*, sotnia of Daghestan Irregular Cavalry with Prince Galitsin; *p*, squadron of Dragoons; *r*, sotnia of Daghestan Irregulars; *s*, Shirvans.

infantry, cavalry.

The practice of the Russian gunners at this conspicuous object was admirable; every shot told as it fell among the kebitkas, and must have wrought terrible havoc among the occupants. After the first fifteen or twenty rounds, dense masses of Tekkeh foot and horsemen, with strings of laden camels, might be seen hurrying from the place and taking the road to Askabad. Upon this the cavalry of the advance guard was ordered to ride round the fort and take up position opposite its northern face, so as to cut off the Tekkehs' retreat in this direction. The dragoons and irregulars accordingly

trotted off, under the command of Prince Chavtavadse, but as they were in the act of crossing the dyke, they were fired at by Kara-Batyr's warriors, who, after the morning's defeat, had concealed themselves behind the earthwork alongside the second mill. They were again put to flight by the Russian cavalry and their leader Kara-Batyr slain. From that time they withdrew from the scene of action, taking the road to Askabad. Hardly had the cavalry crossed the dyke before a mass of Tekkeh footmen rushed out of ambush to attack them. Shanaief quickened the pace of his dragoons and opened fire with volleys, whilst a battery of artillery, under Captain Tsamfort, and eight stands of rockets, began mowing down the startled Tekkehs. These speedily retreated, some towards the fort, others towards mill No. 1. In order to drive the enemy out of this mill and adjoining earthwork, General Lomakin advanced the tirailleur and Kabardinian battalions, leaving the Kurinians to guard the battery. As these two battalions approached the Tekkehs left their cover and advanced to meet them, but a few volleys from the infantry obliged them to retire, and, scrambling across the dyke, they again sought shelter behind the mill and earthwork, the tirailleurs and Kabardinians following closely behind, bayoneting those who had not time to escape. The Russians were masters of the mill and outwork, but the enemy, regardless of a destructive fire from Captain Makuka's horse artillery, retired deliberately in the direction of the large fort, and concealed themselves behind earthworks. In the meanwhile the cavalry continued its movement, leaving a rocket battery, two mountain guns, and a squadron of dragoons along the northern face of Denghil-tepeh, and taking up position in rear of the fort, *i.e.*, on the Askabad road. In this way Denghil-tepeh was surrounded on all sides; in other words, the advance guard, barely over 1,000 men, had formed a cordon round a circuit of over three miles. Crowds of departing Tekhehs were turned back from the Askabad road, and obliged to re-enter the fort, at the same time the irregular cavalry, under Abdul Khalik, drove the enemy out of a small work on the east face of Denghil-tepeh. From these positions the advance guard kept up a desultory fire into the enemy's fort, replied to on the part of the latter by a constant and extremely well-aimed fusillade from guns of all kinds and dates, including some heavy pieces of ordnance. The infernal din from all this firing, wakening the echoes of the Kopet-tagh, was of course a novel experience for the Tekkehs, whilst for the Russians, never imagining that their semi-barbarous enemy would show any serious resistance, it was totally unexpected. But hitherto neither side had put forth its strength, and the battle was yet to come. Finding that the cavalry in the open plain on the north side of the fort were exposed to considerable annoyance from the Tekkehs, concealed behind banks and in ditches, the dragoons were ordered to clear the ground in front of the fort, and Captain Shanaief advancing his squadron, swept at full trot to within 200 paces of the work. Here the ground was marshy and the horses were bogged. Seeing this, a dense mass of the enemy leapt from behind their rampart, and carrying with them all those concealed behind the outer en-

trenchments, rushed with shouts upon the dragoons. These dismounted and opened a sharp fire as the enemy approached within thirty paces of them. The Tekkehs, ten or fifteen times more numerous than the dragoons, continued to advance, though many fell. Obeying the word of command, the dragoons then made a brillant charge, and the Tekkehs, without awaiting the shock, fled leaving twenty dead and wounded on the field. At 3 o'clock, after a march of twenty-four versts under a broiling sun, Borch's column appeared on the scene of action and was at once placed in position, the Grusinian and Erivan Grenadiers on the right, with four Tersky horse artillery and two mountain guns of the 20th Brigade. The Shirvan battalion, with two sotnias of Cossacks (afterwards removed to the Askabad road) formed the reserve under the command of Major Schaufuss behind the large dyke, having in its rear the waggon train, protected by six covering companies, under Captain Kegamof, and consisting of 3,500 camels. The infantry of the advance guard now approached to within 600 paces of the outer rampart on the west face, and extended in line under cover, the sappers and Kurinian battalion on the right, the tirailleurs on the left, overlapping the north angle of the work, and Kabardinians, with two field and two mountain guns, in the centre.

Preparatory to the assault the artillery redoubled its fire. The Tekkehs, however, made no response and gave no evidence of being there. About 4 o'clock in the afternoon, General Lomakin rode down the left attack, opposite the north face, and called for volunteers to enter the work and set fire to the kebitkas in order to create a panic among the besieged, immediately before the assault, for, as he remarked, everything must be finished by the evening. The proposal was a decidedly dangerous one, if not impracticable; nevertheless, twelve dragoons at once jumped off their horses, and running from cover to cover, got within fifteen paces of the rampart. Here they were observed by the Tekkehs who opened fire. Their object was unattainable, and it is wonderful that they should all have escaped unhurt.

Punctually at 5 in the afternoon, four signal guns were fired, and at the same moment five battalions rose from their shelter, and in single line with short intervals between each battalion, dashed at the north and west faces of the work. This was probably what the Tekkehs were waiting for, and in a moment the rampart of Denghil-tepeh was wreathed in smoke, and the plain resounded with the din of battle. Then might be seen a line of white shirts borne forward impetuously, as though racing for a prize—some drop, the colours of a regiment fall, to be immediately hoisted again; there an Officer, Captain Skorino, of the Kabardinians, who, in spite of all remonstrances, insisted on assaulting on horseback, has fallen from his charger; but others are rapidly nearing the rampart; now the Russian batteries are silent; the various battle-cries have died away, and nothing is heard save the occasional muffled report of firearms. All seemed over, but far from it; in half-an-hour, the white shirts reappear in front of the fort. They are barely clear of the

intrenchments, when an infuriated mob of dark Tekkehs are seen in pursuit, brandishing their naked swords. It seemed almost incredible, yet it really occurred. The Kurinians and sappers on the extreme right of the attack, and to the right of the large dyke, after advancing some 300 paces, found themselves exposed to a cross-fire from some formidable detached earthworks, and though they actually gained a footing in them, others not less formidable rose in front of them, and finding it impossible to take these, and that the Kabardinians and tirailleurs were retreating on their left, Major Destoief slowly withdrew his men to their former position, whence they opened a flanking fire on the enemy pursuing the tirailleurs and Kabardinians. These battalions had met with obstacles of no less serious a nature, comprising two parallel trenches, the second 14 feet wide, and of the same depth, a thick earthen parapet 7 feet high, and almost vertical in places, lined with Tekkehs several thick, armed with guns, swords, and with any weapon they could lay hands on. To scale this without ladders was a work of sheer impossibility, and ladders had of course been left behind. Nevertheless, Lieutenant Schmidt, of the tirailleurs, mounted on the shoulders of his men, and reached the top of the parapet, but fell back severely wounded into the ditch, before he had time to draw his revolver. Three other Officers and some men succeeded for a moment in goining a foothold on the parapet, but had to spring back again. They had only time to see fresh lines of defence, and rows of camels forming a living bulwark. Each line bristled with guns and lances, and even scythes stuck on poles. In view of all this, the tirailleurs and Kabardinians could neither advance nor hold their ground in the moat, where men and Officers were falling every minute.

On the north face of the fort the grenadiers had a task of equal difficulty. Here a triple row of kebitkas, arranged in regular order like the squares of a chessboard, only allowed one or two men to pass between them at a time, whilst in rear of them rose the rampart, from which a storm of bullets greeted them. After losing in a few minutes nearly half their men, the grenadier battalions retired.

In this way all five battalions were repulsed from the walls of Denghil-tepeh. No sooner was this remarked, than Berdi-Murad-Khan, commanding the enemy's infantry, called to his Tekkehs: "Now is the time to destroy all the Russians—follow me!" And every creature in the place who had arms of any kind poured forth in a dense mass from the fort, responding to their leader's call, and threw themselves with yells on the retreating Russians, the tirailleurs and grenadiers having to bear the brunt of the shock. A hand-to-hand fight ensued, battalions became mixed up, all order and formation were gone, and in a short time the whole space between the fort and the guns was covered with a general *mêlée* of attacking Tekkehs and defending Russians. At this juncture the Shirvan battalion, hitherto held in reserve, moved forward in close column, with colours unfurled and band playing. A leaden hail meets them, but this only quickens their pace, as with a cheer they dash at the enemy. In a few moments seventy of their men are *hors de combat*, including two Captains and

their gallant leader, Major Schaufuss, shot in the chest. They advance to within a hundred paces of the rampart, but it is their turn to yield, as they retire, closely pursued by the enemy. Carried away in the heat of pursuit, the Tekkehs reach the guns of the horse artillery. Some of their foremost warriors actually lay their hands on the guns, and try and sabre the artillerymen. Then Captain Makuka pours a round of grape into their midst; some dozens of Tekkehs strew the ground in front of the guns, Berdi-Murad-Khan amongst the number. The fall of this chief exercised an important influence on the conduct of the enemy. Turning, they fled, exposed to a hot fire from the infantry, who had recovered its formation. Had they persevered, it is more than probable that, with their numerical superiority, and the determination displayed by them, they would have annihilated the few completely exhausted soldiers. After this brave charge, the artillerymen bayoneted or cut down all the Tekkehs who, in their ardour, had advanced beyond the guns, whilst the grenadiers made ready to renew the pursuit, and halted behind some cover, 500 yards from the guns. Simultaneously with this, another circumstance combined to hasten the enemy's retreat. Considerable numbers of them issued from a gap in the fortifications, near the right hand corner of the northern face, and, passing the rocket battery and half a squadron of dragoons, were rushing after the retreating grenadiers, while several hundred of them took the direction of the battery of mountain guns, under Captain Makuka. It was a critical moment, but Shanaief, without an instant's hesitation, formed his half squadron of dragoons, and taking three half companies of the rocket battery, charged right into this dense mass of Tekkehs. Then ensued desperate slaughter. All the Russian Officers speak in the highest terms of praise of the extraordinary bravery of the Tekkehs. Without waiting for the shock of the cavalry, they slowly but steadily retired, with serious set faces and naked scimeters, turning now and again sharply round to meet the onslaught of the horsemen. Whether inspired by blind fanaticism or some nobler sentiment, they evidently despised death, and met it like heroes. While still among the Tekkehs, the cavalry came under a flanking fire from the grenadiers, and were obliged to retire without completing their work. Nevertheless the object was attained. But if, instead of this mere handful of horsemen, half the cavalry destined to play an inactive part in the day's operations on the Askabad road had been present, the fate of the day would have been far otherwise; at all events, not a Tekkeh who ventured out into the open would have returned again to the fort.

With this cavalry charge the action of the 28th August terminated. The Tekkehs retired behind their intrenchments, the Russians continued to occupy the positions they had taken up, and both sides kept up a desultory firing till dusk. About 8 o'clock the troops began retiring behind the large dyke, and bivouacked in hollow square near the field hospital.

It only remains to add, that the Russian loss in this engagement is estimated at 454 killed and wounded, including 8 Officers killed, and 20 wounded, whilst that of the Tekkehs is said to have amounted to

from 3,000 to 4,000; 246,000 cartridges, 500 rounds of artillery, and 200 rockets, were fired by the Russians.

Thus ended an important event in the history of Russian progress in Central Asia. After six months' preparations, and an outlay of ten millions of roubles, a force, hitherto unparalelled in this country, was assembled.[1] Gigantic labours, heavy sacrifices, were involved in it, and all to launch 1,200 bayonets against a whole warlike people, under the imposing title of six battalions; for, strictly speaking, each battalion numbered only 200, the full strength of a company, when they entered the oasis. It would be interesting and instructive to examine, step by step, the causes which led to so complete a transformation of a seriously concerted plan for a great enterprise. The impartial historian will doubtless give a true picture of this change, but it would be impossible, for several reasons, to do it here. It will suffice, therefore, to show, from a Russian point of view, some of the more glaring errors of the campaign, and the battle of Denghil-tepeh in particular, for those who took part in the action, as well as eye-witnesses, concur in the opinion that, had the 1,200 bayonets been skilfully handled, the Tekkeh fortress must inevitably have been captured, and that the whole affair was grossly mismanaged from beginning to end—elementary rules, even, of the art of war being completely ignored.

To begin with, the troops were brought from the Caucasus to Chikishliar before means of transport had been provided. Whilst waiting for the hire or purchase of camels, the men were unnecessarily exposed to a most unfavourable climate, which bred various diseases among them; and before they could be moved, they had consumed all the provisions prepared for the expedition, and fresh supplies had to be obtained. The same want of transport delayed the march till the end of summer, when the grass was all withered and the corn cut. Had they started in the end of spring, or beginning of summer, there would have been abundance of growing fodder for the cattle, and the corn in the Tekkeh oasis was still uncut and succulent. This error, however, cannot with justice be charged to the late General Lazareff; he had been promised that 4,000 camels would be forthcoming at the proper time, and as many more as were necessary hired. But, when the troops were landed, great difficulty was experienced in hiring camels, whilst of the 4,000 purchased, upwards of three-fourths proved utterly useless.

General Lazareff's plan had been to concentrate from eight to ten battalions at Beurma, with a proportionate force of cavalry and artillery, and intrenching himself there, not to move one step further until two months'supplies, sufficient for his troops, had been collected. Instead of this, only six battalions marched to Beurma, and, halting for one night, continued to advance, with hardly enough rusks to last them ten days. It is impossible to say what could have prevented their remaining for some time longer at Fort Beurma, and employing all their camels in forwarding supplies and reinforcements. Assuredly it was not mortality among these animals; they certainly

[1] 16¼ battalions, 22 sotnias and squadrons, and 24 guns.

perished, as they have done in every steppe campaign, but less than in the Khivan expedition of 1874, and, at all events, far less than was alleged.

The march from Yaradji to Denghil-tepeh in two battalions of nearly equal strength, but separated by so wide an interval that the first wasted its ammunition for four hours to no purpose, while waiting for the second to come up, appears also to require explanation. Half an hour's start for the advance guard would have been ample, especially as both columns marched ready for action. After a fatiguing march in a temperature of 120° F., the men were led at once up to the fortress, no previous reconnaissance or plan of attack having been made. Instead of weakening the battalions by drafting men from each to form a covering column for the transport train, why was not one entire battalion told off for this purpose ?. Numerically weak, the troops were rendered still more so by their extended formation round the fort, so that not only were they unable to support one another, but could not even see what their neighbours were doing to the right and left of them. Again, General Lazareff's invariable rule of parleying with the enemy before the final resort to arms, was entirely disregarded. After the reverse they had sustained in the open, it is probable that the Tekkehs would have come to terms without further bloodshed; indeed, after the first few rounds from the artillery, the friendly Turkoman, to whom allusion has already been made, begged for a cessation of hostilities for two hours, undertaking in that time to persuade his countrymen to lay down their arms; his request, however, was refused, though it was repeated shortly afterwards, some hours before the arrival of the main column, when no serious operations were in immediate contemplation. After the first fifteen or twenty rounds, the Tekkehs began leaving Denghil-tepeh, and retreating along the Askabad road. It seemed as though in a couple more hours the place would have been completely evacuated, and would have fallen into the hands of Russians, together with considerable supplies, which the enemy could not by any possibility have carried with him. But the cavalry was sent round to cut off his retreat, and he was thus driven to fight at all risks. The Tekkehs themselves say that it was only then that they formed the desperate resolve of fighting to the end. Even the Turkomans declared that the assault was unnecessary. Had the Russians kept up the cannonade, and waited in their positions till evening, the place could have been theirs, for every shot fired wrought fearful havoc. They would have been perfectly secure, as the enemy, having learned by experience the futility of engaging them in the open, would not on any account have been induced to leave cover. But the assault was made, and how? Instead of drawing off the enemy's attention by making a feint, in which the dismounted cavalry might have taken part, the troops advanced extended in single line literally without supports—a formation unheard of in military tactics, and even opposed to the laws of mechanics in striking a blow with a widely dispersed and subdivided force. The men advanced with the utmost bravery, but entirely at hap-

hazard. Not a battalion knew what obstacles lay before it, but went straight forward, turning neither to right nor left, to take advantage of any possible facilities for outflanking the defences. The theory of warfare shows that there are always some means of gaining an acquaintance, however slight, with the nature of the enemy's fortifications, but these appear to have been disregarded.

After the battle, firing was discontinued, and before dawn a retreat was commenced. It seems doubtful if retreat were necessary at all, and especially one so precipitately made. Into this, however, it would take too long to inquire, though it is probable, from what afterwards came to their knowledge, that the Russians would have been left masters of Denghil-tepeh, had they waited till daybreak on the 29th August. On the other hand, no decisive results would have been gained, even had Denghil-tepeh fallen after the battle. With a force so greatly reduced by losses in action, with a disorganised transport service, and ammunition running short, Lomakin could not have attempted to penetrate further into the enemy's country, or advanced against Askabad, a position said to be more strongly fortified than Denghil-tepeh itself, and defended by twice as many Tekkehs.

The night passed under the walls of Denghil-tepeh will not easily be effaced from the recollection of those who, fireless, tentless, lay down on the bare earth, among horses and camels, expecting every moment to hear the shouts of advancing Tekkehs followed by the roll of musketry, and then a desperate death-struggle—far from a pleasant prospect for the weary, beaten troops, surrounded by impenetrable darkness, with nerves strung to their highest tension, in the presence of an enemy vastly superior in numbers, and, to make matters worse, chilled through and through by the cold and damp of approaching autumn. Fortunately, however, the Tekkehs showed no signs of animation after midnight, or it might have fared ill with the Russians, orders having been given to fire volleys in case of a night attack, and when it grew lighter it was discovered that the Grusinian battalion was bivouacked in rear of the dragoons, who would have been the first to fall victims to their comrades' rifles—not the only casualty of the kind which might have had occurred had there been a night attack.

At 3 A.M. on the 29th of August the Russians left their bivouack and began slowly retreating along the foot of the Kopet-tagh, this route having been preferred to that further to the right on the open plain towards Yaradji, in order to have the mountains as a protection on one flank and make it impossible for the Tekkehs to entirely surround them.

The column marched in a great hollow square, ready for battle, having its rear protected by a chain of skirmishers, whilst in the centre were the baggage train and wounded, mostly slung on camels, except a few in the Red Cross Society's waggons or in litters. As long as it continued dark they were unmolested by the Tekkehs, who were doubtless ignorant of the retreat. But no sooner was it daylight than their horsemen seemed to spring out of the ground and follow like sharks in the wake of the retiring column, now galloping close up to

it, now halting to fire from their unwieldy guns, manœuvres which excited but little attention beyond an occasional few shots from the rearguard.

The weary camels soon showed that they could go no further, and the packs were transferred to others strong enough to bear them. Then followed a strange sight: hardly had the last files of the detachment passed the abandoned camels than some dozens of Tekkehs might be seen swooping down at full gallop, and fighting over their prey almost within range of the Russian rifles. Progress was greatly impeded by these continual interruptions, and the rate of travel that day averaged barely more than one verst per hour. About noon they halted at a small fort belonging to Nur Verdi Khan, ten miles distant from Denghil-tepeh. The following day the order of march was the same as before, though the distance covered was somewhat greater, and the halt at night was at Kariz, the principal residence and stronghold of Berdi Murad Khan, situated at the foot of the Kopet-tagh and surrounded by land remarkable for its fertility. Here the Russians found large quantities of melons of all kinds and abundance of fodder for the horses. To guard against surprise the men cut down the thick clumps of grass and then lay down as usual with their arms beside them, ready to spring to their feet at the first alarm, a not unnecessary precaution, for between 1 and 2 o'clock the enemy suddenly opened fire, but retired on finding the Russians on the alert, and disturbed them no more that night.

On the third day of the retreat Kariz was left about noon, and before nightfall they joined their old road and reached Durun after a tedious march, embarrassed by the frequent watercourses and irrigating dykes across which the artillery had occasionally to be dragged by hand. The Tekkehs hung always on their rear, eagerly waiting for exhausted camels, but on this and the following days these animals were slaughtered as soon as they showed signs of distress, to prevent their falling into the enemy's hands, and to avoid the annoyance of a too close proximity of his horsemen, ammunition having by this time become scarce. It was enough to melt the hardest heart when the poor brutes received the *coup de grace* from the bayonets of those in whose service they had wasted their strength, and to hear their piteous, childlike cries, as they stretched out their long necks in expiring agony—a feeble protest against the injustice and misery of war.

At Durun two sotnias of irregular cavalry, coming from Bendessen, met the retreating column. The night passed without any event of importance, and from this point the retreat was continued by the familiar road. On the 1st of September they had gone no further than Suntchi, the camels being in such a state that from ten to twenty had to be daily abandoned. The enemy here made an attempt to divert the water supply flowing from the hills, and cavalry and sappers had to be sent to the spot before the water was restored to its natural course.

Though compelled to bivouack in the open without tents, the men had by this time recovered from their fatigue, and were in their

usual health, the cold at night, however, especially in the early morning, was intense, and linen jackets, worn into shreds, were gladly laid aside for the regulation coats. The next day the detachment approached Artchman, and halted at a short distance from its fort, in the ruins of an ancient stone fortress. The Tekkehs again appeared, and opened fire from some neighbouring heights, their bullets flying over the whole camp without doing any damage, and in the morning they vanished. From Artchman the retreat was resumed on the 3rd September, the whole of this day being occupied in the march to Beurma. So exhausted were the men, encumbered with camels weak from starvation, that they could hardly drag along their weary limbs, while the cavalry dozed in their saddles. Never did twenty-five versts seem longer. But on arriving at Beurma everyone felt relieved of a load, knowing that the toilsome journey was almost over, it being generally reported that Lomakin had decided to halt and wait for orders from head-quarters at Tiflis. With the prospect, therefore, of a more or less prolonged stay at Beurma, the Russians made themselves as comfortable as circumstances would permit, taking advantage of the mud huts surrounding the fort, whilst the engineers selected a site for new intrenchments—another proof that the report of remaining at Beurma was well-founded. The Tekkehs only appeared once on the lower slopes of the Kopet-tagh, where the cavalry had a smart engagement with them, resulting in their retiring, leaving one killed and four prisoners in the hands of the Russians. The same day Colonel Navrotsky, returning by way of Kizil-Arvat from a raid against the Atabai Turkomans, joined the column with a division of of Labin Cossacks and a rocket squadron. The next few days were passed by the Russians at Beurma in complete inactivity for the men and anxious expectation for the Officers, the arrival of sutlers from Bendessen with tea, tobacco, wine, and such like luxuries having become the subject of more or less painful longing. But want of transport and the insecurity of the roads prevented sutlers from making their appearance, and though, on the 4th September, Armenians did arrive at Buerma, with the Apsheron detachment, their object in coming was to purchase Tekkeh carpets and rugs, in which they were but indifferently successful, though they had no difficulty in disposing of the stores brought for their own consumption at exorbitant prices.

Early on the morning of the 6th, about half the camels were sent to Bendessen under escort to bring the heavy baggage left behind to Beurma. This again confirmed the hopes of a prolonged stay, when suddenly, about four hours after the departure of the camels, orders were issued for the whole detachment to march on Bami. Every one was, of course, eager to know the reason of this change. It appears that a council of war was held in the afternoon, when it was plainly demonstrated that a longer stay at Beurma was out of the question, provisions and means of transport having failed. For the last two days the horses had been kept on short rations, and even these would not last beyond the morrow. Accordingly the Russians set out from Beurma that day, and at six in the evening bivouacked at the entrance

to the Kozlinsky Pass in the Kopet-tagh, two versts from Bami. Here news was received of the appointment of Lieutenant-General Tergukossoff as successor to Lazareff. This gave general satisfaction in camp, Tergukossoff having earned the reputation of being a good fighting General, and one who would not needlessly expose a soldier's life. That evening news was plentiful. First it was reported that Nur Verdi Khan had entered the oasis with 6,000 men and guns, and was hastening to overtake the Russians. Not more reassuring were the reports from the other side from Bendessen, where the Tekkehs were said to have fallen unawares upon a foraging party and captured some horses, besides killing three and wounding two Cossacks, who thus paid the penalty of culpable carelessness and inattention to prescribed rules. But the most important intelligence was that the next day's march would not be continued to Bendessen, but would stop short of that pass at a point in the defile known as "the Springs," where it had been decided to throw up intrenchments to hold six battalions, who would thus occupy an advanced strategical position in the Kopet-tagh range. At dawn of the following day they set out from their bivouack near Bami, and by 9 A.M. arrived at "the Springs" in the Kozlinsky defile. Here their plans underwent some further alteration, and the cavalry continued the march to Bendessen. This was in consequence of Prince Wittgenstein's report that the forage was exhausted and that men and horses would die of starvation if left at "the Springs." The cavalry accordingly crossed the Kopet-tagh and reached Bendessen at four in the afternoon, fully expecting that the infantry was doomed to vegetate for several months at the dreary spot which they had just left. But to their no little astonishment, about midnight of the same day the whole force arrived at Bendessen with General Lomakin, this move having been found necessary owing to Count Borch's report that his infantry were marching without rations, and that he would resign his command if left there. There were only two courses open—advance or retreat; to remain stationary was an impossibility. News, too, had been brought that Nur Verdi Khan was rapidly approaching with 15,000 cavalry and 15 guns, and that he had vowed to avenge himself for the death of his son and brother. This probably had some weight in deciding matters. But whatever the reasons the position was abandoned and the march resumed. Kopet-tagh's steep slopes told painfully on the tired men and camels. Stragglers that day were numerous, and upwards of 100 camels killed. Thus on the 7th September the Russians abandoned their last foothold on Tekkeh soil, and the same night the last of the Turkomans hitherto accompanying the force deserted. On the 20th September they concentrated at Tersakan, where General Tergukossoff took the command. In the meanwhile a murrain had broken out among the camels, commissariat and transport arrangements utterly broke down, and a further retrograde to the Attrek Valley was therefore necessary; accordingly the whole force was soon afterwards concentrated at Duz-olum, Chatte, and Chikishliar.

Time and space will not allow me to speak of the preparations said to be making to renew the campaign next year. Whether the Russians

ultimately succeed, as they probably will, in reducing these tribes to submission, there can be little doubt that the task will not be an easy one after the experience of the Tekkeh Expedition of 1879.

Table of Distances along Route traversed by the Tekkeh Expedition.

	Versts.	In Oasis.	Versts.
Chikishliar.			
Up Attrek River—		Bami	6
Boyun Bashi	30	Beurma	11
Baiat Hadji	63	Artchman	25
Yagli-olum	21½	Durun	25
Tenidjli	24	Yaradji	26
Chatte	17¾	Denghil-tepeh	24½
	156¼		117½
		Carried forward	292¼
Up Sumbar River—			409¾
Duz-olum	56		
Bek-tepeh	18		
Tersakan	14		
Hodjam-kala	48	About 270 English miles from Chikishliar to Denghil-tepeh.	
Bendessen Pass.			
	136	N.B.—The above distances are merely approximate, and are founded on Colonel Markosoff's map and war correspondence.	
	156¼		
	292¼		

The CHAIRMAN: Perhaps among the gentlemen who have heard the interesting and exhaustive paper read to us by Mr. Delmar Morgan some may have suggestions to make. The practical questions arising from the lecture, if I might venture to say so, are those of transport and commissariat, because their solution might apply to ourselves in somewhat similar conditions.

Colonel LOVATT: I should like to know whether the Russians on this occasion made use of the heliograph.

Mr. DELMAR MORGAN: I am not aware that they used the heliograph.

Captain W. GILL, R.E.: There is one remark of Mr. Delmar Morgan's to which I should like to call your attention. He has spoken of the Attrek as a small stream. I know that at a point considerably higher than where the Russians have been, it is more than a stream, and below that point it receives several affluents. The mere fact of the Turkomans being able to divert its mouth should not lead us to assume that it cannot be called a river, for we know that the course of the Oxus has been changed, and the Russians are thinking of changing its course again. There is also another point to which I should like to call attention. Mr. Morgan says the Russians in their last march were compelled to take water with them. That looks as if the country into which they penetrated was not altogether quite what we should term "a well-watered "country." The country has always been described as "a well-watered country," and I was told so myself when I was in that neighbourhood. Of course what a native of Khiva would call a well-watered country might appear very dry to a Dutchman. My impression is that the oasis is not exactly an oasis as we understand it, but that streams debouch from the mountains, and that at the mouth of each there is, I imagine, a fertile cultivated valley, with sufficient water. The streams cannot penetrate very far into the sandy desert, and they may be separated

by as much as a day or two days' march. I should like to ask if Mr. Morgan knows anything more about that, because he told us they were obliged to take water with them, and it would also be interesting to know what sort of vessels they carried water in. Then, of course, we have to consider what effect the defeat of the Russians will have upon their subsequent movements. That is a large question, but there is no doubt whatever that the expedition is not merely one to punish the Turkomans. It is not so very long ago that we were told that the expedition was purely scientific, and a Russian Officer himself assured me that the chief object of the expedition was to seek after ancient wells. I should imagine by the road they have taken they would go to Sarakhs, which is nearer their objective point. No doubt, Merv is an important position for people coming from the north, but people coming from the fringe of the mountains or through Persia would strike for Sarakhs, and not Merv. With regard to the future operations of the Russians, they will very much depend upon the position Persia takes up. Mr. Morgan says she is rather glad that Russian has come from the north to relieve her of the Turkomans, but I think the Persians would far rather have Turkomans, with whom they can deal if they choose, than Russians, with whom they cannot deal at all. They can keep the Turkomans out if they like, because the latter only move on plains, being entirely cavalry. There are but a few passes through which they can come, and if the Persians stopped up these passes, they could easily keep the Turkomans out.

Surgeon-Major MOORE: Would the lecturer kindly say how the sick and wounded were carried: were they carried on camels, or in litters, or in carts?

Mr. DELMAR MORGAN: They improvised all kinds of transit. Some were carried on litters, some on the shoulders of their comrades, and others were slung in hammocks. The means of transport was very limited indeed: there were only ten ambulances.

Surgeon-Major MOORE: How many were there wounded?

Mr. DELMAR MORGAN: There were 250 wounded.

Surgeon-Major MOORE: It struck me they must have left some wounded behind.

Mr. DELMAR MORGAN: They do not mention having left any, probably they carried them all away, but they carried them in different ways as they best could, some on backs of camels. The wounded must have suffered very much; a great many of them were not attended to during the night after the combat.

With regard to Captain Gill's remarks, he having been there is better able to speak of the country than anyone that I know of. Perhaps the Upper Attrek, to which Captain Gill particularly refers, contains more water than the lower one. At certain seasons of the year the Attrek is flooded and contains a great deal more water than at others, particularly at the end of the summer after the dry season, and in the lower parts, where there is no vegetation in the immediate neighbourhood, it comes to a very small stream. I have no doubt Captain Gill, having been there himself, knows that it is not quite so small a stream, but that was the impression I obtained from reading Russian reports. There are traces, however, of cultivation on the Lower Attrek. No doubt at one time it was a very important river: there are a great number of ruins on its banks. Sir Henry Rawlinson, in a very interesting paper read a short time ago at the Geographical Society, gave an account of this region.

Then with regard to the mode of carrying the water. Water for the men had to be carried in casks and filled at the different wells along the line of march, and sometimes they ran very short of water.

Major TECHEMAKER, late R.A.: Is it not probable, as the account has come from Russian sources, that it is more favourable to the Russian troops and less favourable to the Turkomans than they deserve?

The CHAIRMAN: I am afraid that I have very little to add to the interesting paper read by Mr. Delmar Morgan. Captain Gill, who has kindly spoken on the subject, is one of those who speak from personal knowledge; and I do not suppose there is any better authority than he on that part of the world to which our attention has been directed. He is well known for his geographical acquaintance with those regions; and he is also known in this Institution as having already given us a great deal of information about them. With regard to the Russian expedition against the Tekkes, it will be seen that they have only advanced, probably, half way to Merv. It is by no means

the first time that expeditions have been made by the Russians against the Turkomans, and in that very part of the country. I think we may go so far back as nearly forty years, when they took possession of Ashurada, an island a little to the west of Astrabad. That station was occupied by them in 1841, I believe, ostensibly with the object of assisting the Persians to suppress the Turkoman raids; and, in those days, it was not simply, so far as I understand, raids on shore to be provided for, but attacks from pirate boats. Well, the Russians established a naval station at Ashurada, with the intention of assisting the Persians. How far the Persians wished them to do this is another question, but I believe that records will show they did *not* wish it. Then I think the next time we heard of these expeditions was about ten years afterwards, in 1851. It is some time ago, and the circumstances are almost forgotten, but still they did take place, and they are recorded. In 1851 a number of Turkoman boats came off with these sea-robbers, and set upon the Russian station of Ashurada. It was a convenient time, Easter, when Russians —probably other people do the same thing—enjoy themselves; and they had on that occasion a great festivity. The Turkomans set upon them, killed some, carried off a number of wounded, and disappeared. After this, the Russians resolved upon sending a small expedition against the aggressors, but the report of their intentions and preparations caused so much consternation amongst the Persians that they despatched a special messenger to Teheran to give information on the subject. The origin of these invasions of the Turkoman country must be traced to the first settlement of the Russians at Ashurada. If they had not settled there, that assault upon them would not have occurred; they put themselves consequently in the way of it. Some may argue that the Russians brought all this upon themselves by their wish to assist the Persians, but as the Persians do not appear to have acknowledged that wish, the argument can scarcely hold good: it seems to me rather that the Russians began the proceedings by committing a small act of encroachment. Now, as we see, Russia has progressed into a "Tekkeh Expedition." We are not here to discuss whether this said expedition was intended simply as a punishment of the Tekkehs, or as part of an advance towards a much further goal; but I think the supplies they seem to have taken, and the arrangements they seem to have made, hardly warrant the idea that it was intended to go so far as Merv. Another thing to be observed is, that the Russians have the means of reaching Merv more easily from Charjui on the Oxus. From their relations with Bokhara, they might readily amass a force at this place, whence the march upon Merv is shorter than it would be to come across even from Askabad. It must be twice the distance from Chikishliar to Merv that it is from Charjui to Merv.

I am sure you will allow me to return thanks to Mr. Delmar Morgan for the interesting paper he has read to us.

The following notes on the Lower Attrek have been kindly furnished by Messrs. Stanfords' Geographical Establishment.—ED.

The valley of the Attrek at and above Bujnurd is a wide grassy plain with patches of cultivation and numerous villages, and Captain Napier says that for 50 miles below this it is by no means a desert, although a wilderness without a human habitation. But, at a point probably 50 miles above Chatte, the river begins to cut its way through a plateau of heavy white loam, somewhat resembling pipeclay, and which, after a fall of rain, is converted into a thick mud or paste, which clogs the feet of horses and seriously impedes the advance of wheeled vehicles and the march of foot men. It is described by one of the newspaper correspondents present with this expedition, and to whom we are chiefly indebted for these notes, as resembling treacled paper with the men and horses like flies upon it. At Chatte it has already cut a cañon with vertical walls 90 feet high, and with a width of about half a mile. The river here at the time of the passage of the expedition, was merely a muddy ditch, some 8 feet wide and everywhere fordable for horses, but its channel, which is cut as regularly as a canal at the bottom of this vast ravine, shows that there must at times be a depth of 20 feet of water. What water there was in October, was white as milk and strongly saline, quite unwholesome, fit only for horses and

camels; moreover, it has to be brought up with great labour to the plain above, by zigzag paths cut in the face of the earth cliffs.

The Attrek emerges from the cañon at about 50 miles from the Caspian, the walls here being only about 60 feet high; thence it meanders, spreading into frequent reed-covered marshes, through an unhealthy region, still with a loamy soil, for about 40 miles; when the desert sandy soil is reached which extends for some 10 miles to the Caspian shore.

Apparently there is no drainage over this curious plateau; during hot dry weather the ground is hard and can be traversed in any direction, but after a fall of rain the surface becomes soft and very adhesive, rendering all locomotion very difficult. During winter the passage over the plateau is quite impracticable, owing to the softening of the ground by the floods.—J. BOLTON.

Bujnurd is on the Babuman, a stream that joins the Attrek near a place called Karakhan Banda, about 10 miles below Bujnurd. A high and steep ridge on the north of Bujnurd separates the valley of the Babaman from that of the Attrek. The latter river here runs through a valley about 10 miles in width. On the north it is bounded by a range of hills connected apparently with the main chain of mountains, whose peaks must rise to an elevation of about 10,000 feet. At Pish-Kālā—the last Khoord village—the Attrek was about 35 feet wide, 2 feet 6 inches in depth, and ran 3 miles an hour in November, before any rain or snow had fallen. This gives a discharge of about 380 cubic feet per second at what was probably the driest season of the year.—W. GILL.

OCCASIONAL PAPERS AND NOTICES OF BOOKS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

Lieut.-Colonel Lonsdale Hale having returned to England, it is requested that communications or books for review may be addressed to him, after the 1st January, 1880, at the Royal United Service Institution, Whitehall Yard, London, S.W.

THE TRAINING AND OFFICERING OF RESERVES IN FOREIGN ARMIES.

By Captain H. Hildyard, 71st Highlanders.

The subject to be treated of relates to the Reserves of foreign armies and fall under two heads. Firstly, the degree and the manner in which these reserves are trained, and upon which their relative efficiency in a great measure depends. Secondly, the various modes adopted for officering these reserves. Generally speaking, the systems at present in vogue, not only in Europe, but also in distant countries such as Japan, are copies, more or less precise, of the German organization first forced on our notice in 1866. It by no mean follows, however, that other countries are able to put into the field reserves as fully trained, and as efficiently officered, as those of the German Empire which they have adopted as their pattern. As a fact they are not able to do so, and it is only natural that this should be the case. It is only by long habitude and practice, leading to constant improvement in every detail, that any system can be brought to approach perfection, and of this habitude and practice the German Army alone has had the advantage. Through the restrictions placed upon Prussia's military development and extension by Napoleon, after the Jena disaster, a system of large reserves was founded by Scharnhorst, which led, half a century later, to the crushing defeat of France. Before this, Austria, which had already felt the weight of the Prussian Reserves, had reformed her army system so as to assimilate it with that of her victorious opponent. Italy followed her example, and since 1871, France, Russia, and other European States have done the same. With the exception of Russia, we have had to judge of the results gained by partial mobilization, and without the real

stress of war, with its consequent losses and heavy demands for the supply of Officers and men, being brought to bear. Such judgment can be of only partial value, inasmuch as it is limited to our experience in time of peace, when no pressure has to be met, and when the elements forthcoming are collected with a view rather to instruction and practice than to responsible and independent action. The strength of these elements can be estimated with accuracy so far as numbers are concerned, and we are able to calculate with tolerable correctness the number of effective reserves which the several European Powers could dispose of in the course of a first campaign. Beyond this we can, by a careful estimate of the relative training undergone by the several reserves, and by considering the sources from which their Officers are drawn, form some idea of their relative efficiency. But further we cannot go, and any absolute judgment on the subject would stand every chance of being utterly reversed by the experiences of actual warfare. By the example of Russia we have many lessons to learn, but owing to the war of 1876 having occurred shortly after her adoption of the new system, the example is far from complete. By the law of reorganization of 1874 effect was given to the principle of universal service established in 1870, and the period of service which had been practically for 15 years, though nominally for life, was reduced to six years, with a service in the reserve of nine years. Fifteen years, therefore, were required to produce the results aimed at, whereas the war which ensued necessitated partial mobilization as early as 1876. In place, then, of the 2,000,000 of men which the new system was calculated to put in the field, Russia had at that time a standing army of about 700,000, and a few hundred thousand reserve men, without organization. With a population of 82,000,000 and a law of universal conscription, there could be no great difficulty in placing an almost unlimited number of untrained, or partially trained, men in the field, but to supply them with serviceable Officers was another matter, and the want of these was keenly felt. Thus, in July, 1878, notwithstanding the enormous losses which had been sustained in action and by sickness, the total number under arms was 1,647,795 men, not including Officers, of whom there were 39,268. But even then a portion of the regular army had not been mobilized, and the militia had not been touched. The stubborn bravery of these men, the great proportion of whom received their training on the march and upon the field of battle, proved that, much as such a system is to be depreciated, nations whose people are possessed of the natural qualities of a soldier may, under pressure, produce contingents of ill-trained men which are not to be despised. With the Officers, however, it is different; and it has been clearly demonstrated that without an abundance of highly and carefully trained Officers, supported by intelligent and experienced non-commissioned officers, an army composed even of otherwise superior elements must be at an enormous disadvantage. In the case we have been considering, the army opposed to the Russians was at even a greater disadvantage, so that the defects apparent and the results accruing from them were not so strikingly exhibited as they must otherwise

have been. They were nevertheless sufficient to be markedly apparent, and to impress upon us still more deeply the lessons already taught by former campaigns. Russia herself has not been slow to profit by the experience gained, and in an amended law promulgated in August, 1878, she has provided for a more perfect training of reserves and for a more extensive supply of Officers.

Germany.—We will now proceed to treat separately the systems adopted by the several greater continental Powers, and to discuss their working and results, commencing with Germany as the most perfect in all respects. By the laws of 1814–15, every able-bodied Prussian between twenty and thirty-nine years of age was liable to military service, viz., eight years with the colours, and fourteen in the Landwehr. Exactly the same principle has continued ever since, the only difference being that the limit of liability has been extended, and the several periods within this limit readjusted. Thus at the present moment the liability is between seventeen and forty-two years of age, and these twenty-five years are sub-divided as follows :—

Embodied army service commences at the age of twenty and lasts three years, during which the soldier serves with the colours, though as a rule he is not kept the whole of this time, being dismissed, if thoroughly trained, after two years. With the exception of this period of three years the whole of the twenty-five years' obligation is passed in reserve service of one kind or another. Not only so, but a certain portion of men between the ages of twenty and twenty-three are relegated annually to a special reserve of their own, which is termed the Ersatz Reserve. To it is drafted the surplus of the annual contingent not required to complete the establishments for the year, and also those who from physical inferiority have been postponed on the two previous years to allow of development, and who have not subsequently been embodied. The total number of men attaining yearly the army age is about 400,000, and the requirements of the two services do not exceed 150,000, so that it would appear there ought to be a large margin available, but this is not the case. Between 200,000 and 300,000 are annually postponed for physical improvement, and when all necessary deductions come to be made, the residue only attains to about a half of the requirements. There are, however, postponed men from the two previous years to be re-examined, and of these about 100,000 are usually found available for army service. Adding these to the residue above we get a sufficient number to meet all requirements, leaving a balance of some 15,000 to be drafted to the Ersatz Reserve, but who will be liable during the year to be taken to fill vacancies. These, together with the postponed men of the two previous years not yet taken, made in 1874, for example, a total of 168,500, all of whom belong to the 1st Class Ersatz Reserve, as do also men temporarily granted legal exemption. After five years passed in this, they are drafted to the 2nd Class Ersatz Reserve, which includes also men finally classified as unfit for regular army service, though not utterly useless, men below the standard, and those permanently exempted legally, in which they remain till thirty-two years of age. This is the first category of the extensive reserve

system included in the German organization, and it has been instituted rather as a means of avoiding any escape from military service under special circumstances than for the purpose of providing a substantial reserve. Like every other wheel, however, in the German machinery, it has its special functions, and in 1870–71 seventy battalions were formed partly of Landwehr and partly of Ersatz Reserve men for garrison duty. Since then mixed battalions, in the proportion of 800 Landwehr to 400 Ersatz Reserve, have been regularly organized and attached at the rate of two to each Army Corps for garrison purposes. This refers to the 1st Class only, the 2nd Class being of very inferior material, and, though liable to be called up in case of absolute necessity by Royal Edict, their services would only be required in an extreme case. The training of both classes is *nil*, excepting in accidental cases where men, who should in the first instance have been relegated to the Ersatz Reserve, have been passed for service with the colours, and subsequently have been drafted back. It is on this account no doubt, and because of the heterogeneous and inferior elements of which it is composed, that the Ersatz Reserve is only employed to a small extent and upon garrison duties.

The next category of the reserve with which we have to deal is the direct complement to the regular army, by which the latter is raised upon mobilization to the specified war establishment. To this reserve is passed every non-commissioned officer and man serving with the colours on the completion of three years, with the exception of the small proportion who may have been allowed to re-engage. These men continue to be borne as supernumeraries by their regiments, at the head-quarters of which they join and receive their clothing and equipment in case of mobilization. They are at liberty, however, to choose the district in which they elect to reside, and in case of this not being within the locality of their own regiment, they are permanently transferred to that which appertains to the district. In this reserve the period of service is four years, during which they are liable to periodical musters conducted by companies in the spring and autumn of each year, and also to two periods of drill and manœuvres, each of which is limited to eight weeks' duration. Each recall to active service counts as one of these periods. The first reserve, therefore, by which the active army is brought up to war strength is composed of men between twenty-three and twenty-seven years of age, who have undergone a thorough course of training only a year or two previously. Such of them as have been away from the ranks for any appreciable time are called out for some weeks' training, which are primarily taken advantage of to instruct the men in such changes in arms, drill, and manœuvre as have been introduced since their presence in the ranks. Under these circumstances, and considering the thorough training which is given in the first instance to the German soldier, the reserve men who rejoin the colours on mobilization are perhaps as perfect as soldiers can be made. Superior to those actually serving by the improved physical development consequent upon their age, they are also superior to the Landwehr or older reserves by their more recent training. From this section of

the reserve the soldier passes after four years to the Landwehr, a force originally instituted for the special defence of the country in case of invasion or national disaster, but the use of which has long ceased to be limited to this purpose. Year by year the Landwehr and the reserve proper have been drawn closer together, and even now as a matter of fact the two heads are amalgamated under the one term of Beurlaubtenstand, which has come to signify virtually men on furlough but at disposal. The Landwehr service lasts for five years, during which term, besides an annual muster, there is a liability to two periods of drill of twelve days each. Formerly these were seldom or never enforced, but of late years advantage has been taken of them to instruct the men of the Landwehr concurrently with those of the reserve in the manifold changes which have taken place. This instruction has since the late war been divided into two periods. The first of these, which ended in 1877, was for the specific purpose of instructing the Beurlaubtenstand of the 1873 and earlier contingents in the manipulation and use of the improved rifle issued in 1873-74. In 1877 a decision was arrived at as to the changes to be introduced into the fire tactics of infantry, which after being carefully mastered by the Officers were imparted to the men, and instruction in these now forms the second period for the Beurlaubtenstand. For this it is necessary to form battalions instead of companies, in which formation the first period of instruction was conducted, and two periods of twelve days is found exceedingly short. The objections, from a civil point of view, are however too great to warrant any increase. During 1879 the numbers called out for the purpose were 134,904 non-commissioned officers and men belonging to the fourteen Prussian corps, including Saxony and Wurtemberg, and to the two Bavarian corps. A proportion of Officers is called up with the men of the Beurlaubtenstand, but it is the corresponding regiment of the line that finds the greater portion of the cadres required for instructional purposes. It is partly on this account that the men are directed to assemble, whenever it is possible, at the garrisons of these regiments, and they are accommodated in their barracks, room being made for them, when necessary, by billeting a portion of the former occupants upon the inhabitants. As a rule, the Landwehr are drilled by themselves and formed wherever it can be managed into separate battalions; but this cannot always be arranged, and it may happen that battalions have to be formed from Landwehr men of different regiments, or of Landwehr and reserve men combined. As has been already remarked, the distinction between the two is fast dying out. Although the men of the reserve are only liable to two trainings during their service, the Officers are liable to three; but as a matter of fact they are seldom called up more than twice. Many, however, have to go out voluntarily every year to qualify for promotion, so that in reality nearly half of the total number are out annually. Thus in 1879 there were 2,400 up for training out of the 5,100 borne as reserve Officers. With the Landwehr it is much the same; of the whole number of 5,888 there were 1,781 called out, or about one-third. But many are included in the total who have served beyond the regular term of

service, and are exempted from the periodical drills, so the proportion will be somewhat greater; and as a matter of fact Landwehr Officers, like those of the reserve, are out twice during their service.

The last category of reserves which remains to be dealt with is the Landsturm. This was regarded, until the last few years, as a *levée en masse* of every male capable of bearing arms, who, as a last resource, were to be called up and utilized as the circumstances of the moment might direct. But the steady law of progression, which has presided at every change in the military organization of the Prussian monarchy, and subsequently of the German Empire, aims at something more than this. Until the Campaign of 1866, as has been pointed out, the Landwehr was regarded as a reserve to be used exclusively for home defence. In the following Campaign of 1870-71, this force, however, was extensively used, not only as Etappen troops for service on the lines of communications, though it was chiefly utilized in this manner, but it also took its place in the first line. But the Landsturm was left *in statu quo*, and it might have been thought that no circumstances could arise to render its services necessary beyond the limits of the Empire. Military reformers, however, thought otherwise, and one of the first objects considered on the conclusion of the campaign was, how arrangements could be made to utilize this force in future wars. The question was settled by the law of 1875 By this every man between the ages of seventeen and forty-two, not otherwise enrolled for army service, was rendered liable to be embodied in case, not only of actual invasion, but also of imminent national danger. When called out the Landwehr laws are applicable to it, and it may, in case of urgency, be called upon to fill the ranks of the Landwehr. But as in case of emergency the latter is called upon to complete the active army, the same obligation is in reality incumbent upon the Landsturm, which may practically be called out by the Emperor's order on the first threat of war. Although the men belonging to this reserve are under no military control, and are not called up for drill or exercises, the force is no mean increment to the military power of the Empire. The annual contingent of the active army is 133,800, which, passing into the Landsturm after twelve years' army, reserve, and Landwehr service, may be estimated at the reduced strength of 103,000. Ten contingents at this rate give us a total number of 1,030,000 trained men, without including the levy of youths between seventeen and twenty years of age, which would only be utilized as a very last resource. When it is remembered that the maximum age of these men is forty-two years, the reserve thus obtained is a very valuable one. The chief difficulty which has been experienced is the provision of Officers for this force. The enormous quantity of Officers required for the several portions of the huge forces already organized, has led to every inducement being held out to the Officers of the first reserve and of the Landwehr to prolong their service. It has, nevertheless, been estimated that no less than 500,000 Landsturm men can now be formed into battalions, provided with the necessary proportion of Officers. Special means have further been resorted to for the purpose of supplementing these, and

we may rest fully assured that constant progression will be made until every qualified man between the ages of thirty-two and forty-two will belong to a battalion of Landsturm fully officered and provided with proper cadres in every respect.

Before passing to the special consideration of the officering of the reserve forces, we will briefly recapitulate these under the several heads already mentioned. These may be divided into two portions, one of which has received a regular army training, the other being untrained. Under the former are included :—

1st. Reserve, consisting of 4 contingents of 125,000 men	500,000
2nd. Landwehr, consisting of 5 contingents of 116,000 men.....	580,000
3rd. Landsturm, consisting of 10 contingents of 103,000 men	1,030,000
	2,110,000

The untrained portion is composed of :—

1st. 3 classes from 17 to 20 years of age of 283,000 men	849,000
2nd. 11 classes of Ersatz Reserve of 140,000 men.....	1,540,000
3rd. 11 classes of Landsturm (untrained portion) of 1,118,000 men.....	1,298,000
	3,687,000

These give us a grand total of 5,797,000 reserve men as opposed to 401,659 of the active army. The relative importance of the reserves becomes strikingly apparent when we compare these numbers, and remains sufficiently so if we consider only the 2,110,000 trained men comprised in them.

It will now be our endeavour to analyse the manner in which Officers are obtained for this immense mass of soldiers, and how far the means adopted for this have been successful. The Officers of the reserve and Landwehr are all included under the head of Beurlaubtenstand, and from them those required to raise the army from a peace to a war footing, about 12,000 in number, are mostly taken, a small proportion being obtained from Officers who have permanently retired, or have been allowed to do so, remaining " at disposal."

The sources of supply of reserve Officers proper, are the following :—

1. Officers capable of serving, who have quitted or been removed from the active army before the completion of the legal term of seven years.

2. Officers leaving after the expiration of their legal term, but who are desirous of being attached to the reserve.

3. Non-commissioned officers or men who have specially distinguished themselves before the enemy.

4. One-year volunteers who succeed in obtaining the necessary qualifying certificate as reserve Officers.

5. Non-commissioned officers of the reserve who may obtain the necessary certificate subsequent to the expiration of their term with the colours.

Those under the first head take rank on the reserve list by their date of commission in the line. If they have served for two years in the latter, they have the advantage of being promoted to the rank of First Lieutenant without the probationary period of eight weeks with a regiment, which is otherwise required. The inducements to Officers under (2) to remain on the reserve list in place of being drafted to the Landwehr are that, in case of mobilization, they have the certainty of being placed in active battalions. Nominally they have greater exemption from drills and manœuvres in Landwehr, but as a matter of fact the reserve Officers are not out oftener if the periods spent in qualifying for promotion are excluded, and to these the senior Officers are not liable. The greater number of the reserve Officers, however, are obtained from the one-year volunteers, an institution adopted by all armies recruited on the principle of obligatory service, while in Germany it was introduced as early as 1814. The system has two salient characteristics: it meets a necessity for shortening the service in special cases, which occurs more especially with young men possessing a high order of education, and it answers also a pressing requirement in the shape of reserve Officers. In the first instance, the former of these characteristics was the only one specially recognised, but since 1833 a careful course of training has been instituted with a view to preparing the one-year volunteers for the duties of reserve Officers. Year by year the necessity for a higher standard of education in these Officers has become more apparent, and every year the tests and examinations of those presenting themselves as candidates have been made more severe. Thus since 1872 of 304 candidates in one district only 155 have been admitted, and at the spring examination this year at Berlin, 50 failed to qualify out of 78. It may in short be taken as an average that about one-half of the number annually presenting themselves for examination are unsuccessful. Those who are admitted are bound to clothe, equip, and maintain themselves, fulfilling which conditions, they pass to the reserve after one year's service; should they, however, fail to do so, they are held to serve their full three years with the colours. The course of instruction of the one-year volunteers is specially framed with a view to training them for the position of Officers, or failing to reach the required standard for this, of non-commissioned officers in the reserve. The first six months are invariably spent by the one-year volunteer in the ranks as a private soldier, after which probation, should his character and proficiency in his duties admit of it, he is appointed *gefreite*, the lowest grade of non-commissioned rank. He then receives both theoretical and practical instruction in all the branches of technical knowledge judged necessary for Officers and non-commissioned officers of the

reserve, and these extend over a large area. Such as have not shown the necessary qualities are not placed upon the list of *gefreite*, excepting in some cases as supernumeraries, when they do not participate in this instruction. On the conclusion of the course an examination is held, which is conducted by a standing board consisting of a Captain commanding a company as president, with a First and Second Lieutenant as members. Before entering upon the examination three certificates have to be produced by candidates. The first is that of nationality, the second of good conduct from the Officer commanding the company to which the candidate belongs. In this it must be specifically stated whether from his professional knowledge, by his birth, his intellectual and physical qualifications, his means and social position, the candidate is likely to make a proper reserve Officer. He has also to produce a detailed "*curriculum vitæ*." The examination, which is partly on paper, partly *vivâ voce*, and partly of a practical nature, follows. The subjects for the two former include the conditions and duties of military service, in garrison and in the field, the use of the rifle, and the regulation drill exercises. The practical portion embraces battalion drill as commander of a subdivision, rifle exercises, field movements with a detachment, and with two opposed one to the other under a general idea, and the writing of reports on the operations performed. The candidate having been pronounced qualified, the Officers of the corps are assembled by the Commanding Officer, and the board makes its report, which is supplemented by Captains commanding the companies to which candidates belong. After this the latter are dismissed to the reserve, in which they are as a rule attached to their own arm of the service. The following year they are called up to attend exercises, which last ordinarily for eight weeks, during the course of which the manner in which they perform their duties as well as their social conduct is carefully observed. On the conclusion of these they are proposed as Officers of reserve by the commander of the district, who is responsible for satisfying himself first that their means of support and their social position are such as to warrant his doing so. Each individual is then dependent upon the votes of the Officers of the corps to which he is attached, and which are based primarily upon his character and good conduct. So far as the theoretical course of training is concerned, there remains little to be desired; and it might consequently be supposed that upon developing into a reserve Officer the one-year volunteer would be found to make a very efficient one. This, however, has not proved to be the case, and if we examine the question we can hardly wonder at this. In the first place, however carefully the course of training may be conducted, the time at disposal cannot but be quite inadequate. The first six months have, as we have seen, to be passed in the ranks, and only a period of the same duration is left for the study and practice of the many subjects previously recounted. The time would be too short in any case, but it is so particularly under the actual system; the one-year volunteer's instruction for the most part being a very secondary consideration, the principal attention being directed to the training of the more permanent portion of the corps. This is

we believe, in course of being remedied, an extra Captain being appointed to each regiment, whose special duty it will be to conduct the training of the volunteers. However far they are from attaining to perfection, there can be no doubt that they are a class of intelligent, highly educated young men, grounded in the rudiments of military knowledge, and requiring only practice and experience to make them valuable Officers. Drafted, as they would be in case of mobilization, to the active army to fill vacancies in the lower ranks caused by promotions upon augmentation and transfers to the Landwehr, they are quite fitted to take their place in companies as subordinate Officers. Reserve Officers are liable to three periods of drill not exceeding eight weeks each, and irrespective of any qualifying service. They receive promotion on the same date as the Officer next junior to them in the line. On the completion of their army and reserve service they are drafted to the Landwehr, unless specially continued in the reserve for a further period not exceeding five years. They may also be transferred to the Landwehr if they become unfit for field service, or if from their absence abroad they are unable to fulfil their obligations in the reserve. The total number of reserve Officers at the commencement of 1879 was 5,130, distributed as follows:—

Infantry	2,927
Chasseurs	71
Cavalry	1,312
Field Artillery	470
Foot Artillery	85
Engineers	59
Railway Regiment	81
Train	125

all of whom were subaltern Officers with the exception of 35 Captains, nearly the whole of the remainder being Second Lieutenants. The proportion of infantry Officers to the numbers borne on the active list, when the peace establishments are complete, is about $\frac{2}{3}$ths, a large proportion, but still no more than is required to complete the line upon mobilization on account of the large numbers drafted from the latter to new formations. The cavalry are, on the other hand, considerably in excess of the numbers required, which is accounted for by this arm being the more popular service with one-year volunteers. This excess is utilized in the Train, which is badly off for reserve Officers and requires a considerable increment on taking the field. The field artillery number about one-fourth of the normal active list; and this is probably sufficient, for the changes and new formations are much fewer in this arm than they are in the line. The numbers attached to the Railway Regiment are very large considering the actual formations, and it is generally supposed that they would be employed on the Etappen Commissions formed along the lines of communications during active operations. The Officers of the Landwehr bear a very close relation to those of the reserve, even closer perhaps than is the case with the men, for many of them are upon the first mobilization utilized in the active army. They are, however, retained upon separate

lists, and serve to a certain extent under different conditions, their obligations not being so extensive as those of the reserve Officers. In ordinary times the lists are recruited (1) from Officers quitting the active army, and who have completed their legal term of seven years; (2) from Officers transferred from the reserve on the expiration of their service in it, or for any of the causes already enumerated. The numbers thus obtained, though sufficient for a first mobilization, are not sufficient to allow of the necessary margin over immediate requirements, and the following sources are then also utilized:—(1) Landwehr men who have distinguished themselves in the field; (2) non-commissioned officers and men who have obtained certificates of qualification as reserve Officers, but who have not as yet been appointed; (3) non-commissioned officers who have been discharged from active service with a recommendation for their employment in this capacity. The two former must agree before appointment to serve for a period of five years, and those under the second head must have served voluntarily for not less than six weeks with the line. In each case they must be regularly accepted by the Officers of their regiment.

Landwehr Officers bear the same relation to those of the line as do reserve Officers, and must like them qualify for promotion in peace time by a voluntary service with the line. The commanders of Landwehr companies receive a monthly allowance of 30*s.* for travelling expenses, which is the sole instance of Officers on the furlough list being paid unless called up for regular duty. During these periods, whether for drill or for service, the whole of them receive the same pay and allowances as Officers of like rank in the active army. They are subject to the same laws so far as military offences are concerned, and their interior social economy, including courts of honour, is based upon that prevailing in the regulars. So long as they fulfil the ordinary conditions of Landwehr service, including the periodical exercises of thirteen days, twice during their term of service, they may live where they please. To qualify for promotion a period of drill with a regular corps of from four to eight weeks' duration is required, after which promotion is conducted on the same principle as that of reserve Officers. The number of Landwehr Officers at the commencement of 1879 was 5,888, distributed amongst the several arms as follows:—

Infantry	3,990
Cavalry	983
Field Artillery	327
Foot Artillery	225
Engineers	87
Railway Regiment	135
Train	141

The natural disposition of these upon mobilization is to officer their own battalions, but if we take the numbers available by ranks, it is apparent that they cannot alone suffice for this. The infantry numbers, as we see, 3,990 Officers, but of these only 12 are Field Officers, and only

a few over 200, Captains. The rest are First and Second Lieutenants, the latter predominating. This difficulty is met by a happy interchangeable arrangement under which each regular regiment provides upon mobilization from four to six company commanders, together with superior Officers and staff, to its Landwehr battalions, receiving from them in return Officers to fill the vacancies thus caused. The Officers of the Landwehr are naturally more highly trained than those on the reserve list, for there is a much larger proportion amongst them of men who have served for considerable periods in the active army, whilst of the rest most have been passed on from the reserve after completing their full term in it. A large number also prolong their service in the Landwehr after the expiration of their legal period. Thus, though the proportion of the higher to that of the inferior ranks remains small, the length of service of Officers is considerable, as will be seen by the following:—At the commencement of the year there were 888 of over twenty years' service, and who are distinguished by the term of 1st Class Landwehr Officers. Of between fourteen and twenty years' service, there were 1,894, making a total of 2,782, or about one-half whose service exceeded the legal term, whereas in the reserve only 293 fell under this category.

Considerable as are the numbers of reserve and Landwehr Officers in the categories which we have enumerated, they are not equal to the requirements upon mobilization so far as the infantry is concerned. This arm requires at the war strength no less than 17,714 Officers, including the regular army, the 4th and reserve battalions raised in each regiment on mobilization, and the Landwehr. To supply these, we have actually serving 7,396, while the reserve and Landwehr lists number 2,998 and 3,990 respectively, making a total of 14,384, or 3,330 short of the actual requirements. In the above numbers, however, are not included some 1,000 Officers of all arms who remain at disposal, although borne neither on the strength of the reserve nor of the Landwehr. They are mostly superior Officers, and not more than a third are qualified for full service, but the remainder are capable of local and etappen employment. Besides these, again, are the class of non-commissioned officers previously referred to when treating of the sources of supply for Landwehr Officers, and who are only appointed on a mobilization taking place. These include all the Vice-Feldwebel and non-commissioned officers of reserve and Landwehr who have left the colours with an Officer's qualifying certificate, and may be computed at from 2,000 to 3,000. The greater proportion of these, as also of the Officers at disposal, belong to the infantry, and between them they may probably be counted upon to fill up the deficit of 3,330. But this is, to say the least of it, a very close calculation; and if we allow for the numbers short of establishment, which on the outbreak of the war of 1870 were very considerable, they would prove inadequate even to complete all the first formations on a general mobilization. To remedy this state of affairs, and allow a margin for other purposes, a new rank was, by a Cabinet Order of the 13th November, 1877, introduced into the Landwehr. The holders of this are styled *Feldwebel*-Lieutenants of the Garrison

Army, and occupy an intermediate position between the Officers and non-commissioned officers. They are recruited from the senior non-commissioned officers qualified to perform Officers' duties in case of war, but who do not possess the requisite educational attainments and social position to entitle them to be embodied in the corps of Officers. They are not allowed to assume either the title or uniform of an Officer, but in other respects they have all the advantages of Second Lieutenants, after whom they rank, receiving *letters of service* in place of *Officers' commissions*. Candidates are required to serve on probation for three months with the rank of Vice-Feldwebel, after which, if satisfactory, they may be appointed Feldwebel-Lieutenant, the Officers' vote being dispensed with. The number of these which would be available has been estimated at from 4,000 to 6,000. Further than that their services are to be confined to employment with the garrison army we have not been officially informed how they would be utilized. It has been stated, however, that it is proposed to appoint two to each company of Ersatz, which, as previously noted, are to be combined with Landwehr companies for garrison purposes in the proportion of two battalions per Army Corps. As only one-third of these are to be Ersatz men, the number of Officers for this purpose would not be large, and may be estimated at from 120 to 150. From the residue it is proposed to fill up such Landwehr battalions as might not be mobilized, the number of which would entirely depend upon circumstances, and would rule the number of Feldwebel-Lieutenants to be employed in this manner. It is calculated that enough would still remain to form a very useful nucleus for the Landsturm. For the latter, however, alone, no less than 5,286 would be required to officer the formations for which material would, in the first instance, be available; so that at present, at least, this new source cannot be counted upon to meet all requirements. It is, however, one more of the series of progressive steps which have led during the last half century to the perfection of the Prussian system of military organization and training. There is little doubt that this last step will be supplemented and completed in every detail, so as to meet fully the requirements for which it was instituted. In the meantime we have, in the reserve and Landwehr alone, over 10,000 Officers ready to take their place with these trained forces, numbering no less than 1,080,000 men, while leaving behind enough to officer the depôt battalions and provide a nucleus for the Landsturm formations.

France.—If we take actual numbers as our guide, the Army of the French Republic is inferior to no other, either in men or in Officers. But this result cannot be fully attained for some years, and will then be the product of a new organization, foreign to the institutions of the country. The enormous force which will be then available will still be necessarily wanting in the cohesion and systematic training which have been inherited as a second nature by every individual of the German Army. The old system of prolonged service, exoneration, and substitution fell with the Empire and with the reverses experienced in the late war. In 1872 a new one was introduced, to the formation of which the German system contributed extensively.

Its basis was a strict obligatory personal service, extending in one form or another over a period of twenty years. Divided into terms of five years in the active army, four years in its reserve, five years in a territorial army, and six years in a territorial reserve, the twenty contingents are counted on to produce no less a force than 3,750,000 men. As with the German Army, those actually serving form a very small proportion of this number, averaging, as they do, about 408,000 men, or if we include those dismissed to furlough before the expiration of their five years with the colours, 704,714. The whole of the remainder, although borne under different conditions and titles, come under the generic head of reserves. The number annually attaining the legal age of twenty-one is 312,000. Of these 267,000 draw lots and are retained on the lists. These are, in the first instance, divided into two categories, one of 146,000, the men included in which are attached to the active army, the other of 121,000, who are excused from service with the colours. Of the 146,000 drafted for army service, 92,000, which comprise what is termed the first portion, serve with the colours nominally for five years, though in reality a great proportion of them are dismissed on furlough after three years' service or when considered efficient. The remainder, called the second portion, and numbering nominally 54,000, serve with the colours a minimum period of six months, which may be prolonged to one year. Of the second category of 121,000 men, 70,500 are dispense from service, though about 45,000 of these are liable to be called up in time of war. The auxiliary services absorb 28,000, while the residue of 22,000 are postponed for various causes, about 6,000 to 8,000 being probably taken the following year. In time of peace no training is provided for the men composing this category of the contingent; but they are legally subject to it should the military budget admit at any time of their being so. Both categories pass after five years from the lists of the active army to those of the reserve, upon which they are borne for four years. During this time they are called out twice for periods of drill not exceeding twenty-eight days each, which are fixed for the second and fourth years of service in the reserve, and are timed so as to embrace the period of autumn manœuvres. In 1878 the classes of 1869 and 1871, numbering 310,000 men, were called out for this period. On the expiration of the four years' reserve service the men are drafted to the territorial army to which they belong for five years. During this time they are subject to an annual muster, and to periodical embodiments for drill, the duration of which are not limited by law. In 1878, for the first time, a portion of the territorial army was called up, and the success of the experiment surpassed expectation. All the Officers and non-commissioned officers, and such of the men of the infantry and artillery as had received previous training, belonging to the contingents of 1866 and 1867 were out upon this occasion, numbering about 150,000 men. There were very few absentees, and during the fifteen days during which they were up, most satisfactory results were obtained. The infantry men were assembled at the depôts of the regular regiments in their respective districts, which are

the places of assembly on mobilization, and there they received their arms and clothing. The chief object of the instruction was to train the men in the use of the new rifle (pattern of 1874), and it was conducted by Officers and non-commissioned officers of the active regiments. This, however, is only a temporary measure, and it is intended that, so soon as the cadres of the territorial regiments are capable of undertaking the training themselves, it shall be left entirely in their hands. The artillery men assembled at their brigade head-quarters and were trained, the garrison men in the working and firing of the new 138 mm. gun, in rifle instruction, and in the construction of batteries; the field artillery in the use of the pieces lately allotted to the territorial army, and in carbine and revolver practice. So far as the men were concerned, the reports as to their efficiency were universally good, but there were great complaints both as to the Officers and non-commissioned officers. The military journal, "L'Armée Française," went so far as to declare that from one-quarter to one-third of the total number of Officers were incapable, and there is no doubt that they left much to be desired in the way of efficiency. During the course of 1878, however, two laws were passed, which, it is expected, will do much to remedy this state of affairs. The one creates a new scale of pensions for Officers, which compares favourably with that previously in force, and enacts that all Officers entitled to pension who may elect to come under it may do so, on the condition of being liable to service in the reserve or territorial armies for a period of five years. The other law, bearing date the 22nd June, 1878, regulates afresh the whole conditions of service, re-engagement, and pension of non-commissioned officers. It is so far favourable to this class, that it is looked upon as settling definitely the difficult question of the supply of non-commissioned officers, which has given France, in common with most other military nations, considerable trouble of late years. By this law a pension is granted to them after fifteen years' service, on the condition of their serving for four years in the territorial army, an enactment which cannot fail to be of very great value. In 1879, all the men of the infantry and artillery of the same classes, who were not out in the preceding year, were called up. In 1880–81, it is proposed, in like manner, to call out the classes of 1868 and 1869, and so on, until the principle of obligatory service applied to all classes of the contingent shall have abolished the present numerous class of men who have never belonged to the Army. When this time shall have arrived, an entire class will be called up annually. The fourth and last portion of the obligatory service, now incumbent upon every Frenchman, is spent in the reserve to the territorial army, which can hardly be said to have been called into existence, so far as any organization or training is concerned. When, however, every man passing into it from the territorial army has spent some years with the colours, and been subsequently called up for periodical intervals of drill and instruction while serving in the reserve and territorial army, it will comprise a very valuable body of men of an age between thirty-five and forty-one.

Turning now to the question of the supply of Officers to complete

the establishments on augmentation by the reserve, and to provide the territorial army when called up and organized for service, we find that they are borne on two separate lists. By the law of the 13th March, 1875, a cadre of reserve Officers was created, to be borne as supernumeraries, for the purpose of completing the various arms and services of each army corps upon mobilization. So far as can be arranged, they are intended to return to the corps in which they have previously served. The following are the sources from which the nominations to this reserve are made:—

1. All Officers, of whatever grade, retired on a pension under the law of the 22nd June, 1878, whether combatant or departmental, remain at the disposal of the Minister of War for the five years following their retirement. During this time they are liable to service in the reserve with the rank upon which they retired, or to be employed in the territorial army, in which case they may be granted a rank higher than that previously held by them. The length of service required before this pension can be claimed is thirty years, so that the Officers rendered by this new arrangement available for service with the reserve and territorial troops will necessarily be men of great experience, and cannot fail to be a very valuable element.

2. Such Generals and departmental Officers of equivalent rank as have retired, upon application being made by them to that effect.

3. All Officers, combatant and departmental, who have been allowed to retire after twenty-five years' service, will belong to the reserve until they shall have completed thirty years' service. Those retired after the latter term will only be included upon their own application.

4. Officers who have retired from the Marines, and are not subject to naval service, may join the reserve if they wish to do so.

5. Retired Officers, combatant or otherwise, who are exempted by their age from any further obligatory service either in the active army or the reserve, but who apply to serve in the latter.

It is especially pointed out that candidates embraced under these headings must be possessed of the requisite physical and moral qualifications.

6. Such pupils from the Polytechnic and Forestry Colleges as have graduated successfully, and have not taken service in the Army or Navy. These receive a commission as Sub-Lieutenant in the first instance, but as they advance in the civil grades of their respective branches of employment, so their rank in the reserve is increased. Thus from the Polytechnic Schools we find the lower grades under the departments of State manufactories, telegraphs, and highways, styled respectively student-engineers and student-inspectors, and ranking as Sub-Lieutenants; while the first class directors, inspectors, and chief engineers rank as Lieutenant-Colonels. It is the same with pupils from the Forestry Schools. The whole continue to belong to the reserve until the expiration of the double term of active and reserve service, excluding from it such time as has been passed by them at college.

7. One-year volunteers who have passed the prescribed examinations at the close of their twelve months' service, may, by remaining another year with the active army, or in a college specified by the Minister of

War, and passing such further examinations as may be required, obtain a Sub-Lieutenant's commission, entitling them to be enrolled on the reserve list of Officers, on which they continue until passed to the territorial army.

8. Officers of the ex-National Guard who, under the Law of the 27th July, 1872, were made supernumerary Sub-Lieutenants, on condition of satisfying a prescribed examination.

These are the main sources from which the reserve list of Officers is supplied, but there are one or two others from which a certain number are drawn. Young men belonging to the reserve or at disposal, and exercising the professions of medicine, pharmacy, or veterinary art, may receive commissions in their special branches provided they are in possession of the necessary diplomas. Non-commissioned officers who have completed their time with the colours, and have been transferred to the reserve, with certificates from their Commanding Officers of their aptitude for the position of Officers. Lastly, non-commissioned officers who belonged formerly to the National Guard, and who satisfy certain necessary conditions. With the exception of such as have previously served as Officers in the active army, who enter the reserve with their former rank, and are susceptible of further promotion, no reserve Officer can in time of peace rise higher than to the grade of Captain if a combatant, or to the corresponding relative rank if a departmental Officer. They cannot, under any circumstances, with the same exception, perform the duties of Commanding Officer of a corps, department, or depôt. The rank being equal, Officers belonging to the active army are entitled always to command over those of the reserve. Of the latter, those who have formerly served retain the right of command by their seniority at the time of leaving. On the expiration of their legal term of active and reserve service, all Officers of the latter, with certain exceptions, such as those attached to it under paragraph 1, pass to the territorial army. The status and general regulations for reserve and territorial Officers were fixed by a Decree of the 31st August, 1878, which places the two classes upon one and the same footing in the following respects.

Their commissions are granted under a decree by the President of the Republic upon the recommendation of the Minister of War, and they can only be deprived of their position as Officer by resignation duly accepted, by civil conviction entailing certain sentences, by cashiering by a court-martial, and by their appointment being cancelled by the President's decree. This latter follows as a matter of course upon a declaration of bankruptcy, and upon being removed from the functions of ministerial Officer under certain conditions. It may also be resorted to upon the recommendation of a court of inquiry in various cases where Officers are shown to have been guilty of misconduct. These courts are assimilated to those prescribed for the active army, and are composed of Officers from the latter and from the reserve or the territorial army, combined.

The numbers of Officers borne upon the reserve list in 1878 was 5,341 in the combatant branches, distributed as follows:—

Infantry—3,259; viz., 250 Captains, 19 Lieutenants, 2,990 Sub-Lieutenants, and 14 supernumeraries.

Cavalry—626; viz., 81 Captains, 545 Lieutenants and Sub-Lieutenants.

Artillery—1,036; viz.; 5 Captains, 1,031 Lieutenants and Sub-Lieutenants.

Engineers—150.

The infantry Officers are rather more than a quarter of the number belonging to the active army, which is 11,272, and are in excess of the requirements upon mobilization. The cavalry also has more Officers on the reserve list than would be required, but it is short of 80 Captains. The artillery is inadequate to its augmentation, although numbering nearly one-half of the total of the active Officers of this arm, which is 2,677, not including 248 attached to the artillery train. Several measures have been adopted, so as to obtain the numbers required. Several institutions, for instance, which had hitherto sent candidates as one-year volunteers to the corps of engineers are to draft these to the artillery instead, independently of the proportion already yearly attached to this arm, which is 19 per cent. of the total number allowed. Besides this, the one-year volunteers of the cavalry and engineers who obtained a certificate of "very good" at the final examination were directed to be transferred to the artillery as aspirants for appointment as reserve Officers. By this means no doubt the deficit will long ere now have been supplied; but if complete, the elements of which the list is composed can hardly be very satisfactory. As we have seen, there are only 5 Captains, and the bulk of the remainder are Sub-Lieutenants, most of whom have been supplied by one-year volunteers. In treating of the German reserve Officers, we pointed out the increasing care which is taken to ensure the one-year volunteers being, as far as possible, superior both by natural qualities and by education.

The same care, which is the only safeguard for the efficiency of the bulk of the reserve Officers, does not seem to be taken in the French Army, and the consequence is that the same material is not generally obtained for this important class. On the other hand the reserve of the French infantry has on its roll 250 Captains, whereas in Germany there are but 10, which has to be made up for by transferring a number of Officers of that rank from the active battalions to the new formations upon mobilization. The results of the German system, as shown in more than one campaign, have certainly left little to be desired, and it may be that in reserving the great part of their Captains for the Landwehr formations they are in the right.

The territorial army derives its Officers from the following sources:—

1. Officers, whatever their rank, who accept a pension under the Law of 1878, and whose services are not required in the reserve to the active army. As an Officer only becomes entitled to a pension after thirty years' service, most of these Officers will necessarily be of the higher ranks, and will no doubt be allotted, as a rule, to the territorial army in preference to the reserve, and will introduce into it a much required element.

2. Officers of the Army and Marines who have retired from those services, and who by their ages belong to the territorial army.

3. All those borne on the reserve list upon their completion of the legal term, unless they are retained upon it at their own request.

4. Non-commissioned officers of the reserve who succeed in qualifying at an examination held for the purpose, on their passing by age to the territorial army.

5. One-year volunteers who have been declared qualified for the post of non-commissioned officer on the expiration of their year's voluntary service, and who pass a qualifying examination on being drafted to the territorial army.

6. Men formerly belonging to the ex-National Guard and the mobilized corps, who have completed their reserve service and passed a prescribed examination. The ranks of Sub-Lieutenant, Lieutenant, and Captain, in the territorial army, have been given to men of this category after examination; but this test has not been required from such as held superior rank in the Garde Mobile, who have been nominated with their former grade. These dispositions are entirely transitory, and have been made partly as a reward to men who proved their bravery and devotion in the late war.

Superior Officers can be retained at their own request, if approved of by the Minister of War, until the age of sixty-five, in the territorial army, and those of inferior rank until sixty; Officers of this army are entitled, as has been already stated, to the same prerogatives, and subject to the same conditions, as Officers of the reserve to the active army.

The number of Officers shown as belonging to the territorial army in 1878 was about 10,000, of which 7,797 belonged to the combatant branches in the following proportion:—

Infantry	5,694
Cavalry	790
Artillery	926
Engineers	387

By the Law of July, 1873, the following was to be the organization of the territorial army, viz.:—145 regiments of infantry, 76 squadrons of cavalry, 294 batteries of field, 40 companies of garrison artillery, and 49 companies of engineers. With the exception that the regiments are commanded by Lieutenant-Colonels in place of Colonels, the organization is the same identically as that of the active army, so that the actual number of Officers would not more than suffice to complete one-half of the 435 battalions which have to be provided for. The cavalry requires but a comparatively small number of Officers to make its cadres complete. The artillery can provide for about two-thirds of its requirements, and the engineer corps is nearly up to its proper strength. But apart from the shortness of establishments, the Officers of the territorial army are not, up to the present time, as efficient a body as could be desired. They are composed of the most heterogeneous elements, and a great proportion of them are not equal to the

duties they would be called upon to perform in time of war, and not of very great use in time of peace. All this will, however, no doubt, be remedied in course of time. The force, as a body, has laboured hitherto under the greatest possible disadvantages. The product of a new organization, it is only by the careful regulation of every detail, and by regular periods of training, that it can possibly be got into anything like working order. As a matter of fact, it is only from 1878 that the matter has really been taken in hand. Then, for the first time, a portion of the force was called out for drill, enabling such shortcomings as became apparent to be investigated, and measures adopted to rectify them. The weakest point was seen then to be in the Officers; and this has become still more evident since. No time has been lost in trying to remedy this defect, and measures have already been adopted which will go far to diminish it, though time will be required, above all things, to rectify it altogether.

Austria.—Though based upon the German system, the Austrian organization differs from it in many material points. The Law of 1869 provided for universal military service for a period of twelve years, to be divided into three terms passed in the active army, its reserve, and the Landwehr respectively. Thus the total liability is little more than half of what it is in Germany, without counting the three years' Landsturm service of the latter before the age of twenty. The several terms in Austria are, three years with the colours, seven with the reserve, and two in the Landwehr, the preponderance being given to the reserve, and the Landwehr embracing only the two oldest contingents, the youngest of which will have been seven years away from the ranks. In Germany, on the contrary, the longest term is spent with the Landwehr, viz., five years, and it is more evenly divided by the reserve service being fixed at only one year less. Including Hungary, about 330,000 men become yearly liable for military service, the remainder of whom, after deducting those rejected and deferred for various causes, are divided amongst the active army, the Ersatz, or recruiting reserve, and the Landwehr, the recruits being drafted to one or the other, according to numbers drawn by lot. The war strength of the standing army and its reserve was fixed, by a law passed in 1868 and which has since been renewed, at 788,000 men, and the peace establishment at 252,000. These are supplied by an annual contingent of about 95,000 men, of which 54,541 are supplied by Austria, and 40,933 by Hungary. Besides these, are taken for the Ersatz Reserve 5,454 and 4,093, or in all about 10,000 men annually, to keep it at a strength of 97,000 men. These are allotted to the different branches of the service, according to their fitness, but they are exempt during peace from all drill or service, excepting such of them as may be called up to fill vacancies during two succeeding years. In time of war they are employed to keep the formations up to their establishments. After three years spent with the colours, or on furlough in the case of such men as may be dismissed before the expiration of that period, the men are drafted to the army reserve, where they pass seven years, during which time they are

liable, besides an annual muster, to three periods of drill, each of four weeks' duration. If called out for active service, it is counted as one training. During the first nine years' service they may, when called up on mobilization, be attached to either the Landwehr or the Reserve, but during their tenth year, they are liable only to service in the former. These three categories, the active army, the Ersatz Reserve, and the reserve to the active army, which may be estimated after making the necessary reductions for waste at about 1,194,000 men, form the sources of supply for an army taking the field. With the exception of the 97,000 men of the Ersatz Reserve, all of them have been thoroughly trained, although a great proportion will have been some years absent from the ranks. The force for home defence is composed of the Imperial and Royal Landwehrs of Austria and Hungary respectively, and of the Landsturm of the latter, for there is none in Austria proper, and indeed, its present Landwehr formation only dates from 1872, when it was assimilated to that of Hungary. This force is recruited as follows:—

1. Men who have served their regulated time in the active army and the reserve, and who serve for two years.

2. Those who are incorporated at once, having escaped service in the active army, and in the Ersatz Reserve, and who are liable to service for twelve years.

3. Men under thirty-two years of age, who, though they have attended the conscription, have not been enrolled. These are only liable during the continuance of war.

4. Volunteers from men not liable, who are accepted for two years or during the period of a war.

The men regularly borne on the strength of the Landwehr are required to attend an annual muster held in each company district. There is every year a fortnight's company drill in the autumn, and every other year battalion drills of three weeks' duration, during which time the Landwehr may be combined for manœuvres with the standing army. Those men who join the Landwehr direct, without having previously undergone army service, are put through an eight weeks' course of training upon first joining, at their battalion headquarters. In time of peace, one company per battalion, and one cadre per squadron, to be completed in time of war, are permanently embodied at the head-quarter station, as a training staff. The Landsturm is furnished by Hungary only, and it has no cadres in time of peace. It is formed from volunteers, who elect their own Officers and non-commissioned officers, and can only be called out when the country is threatened with invasion.

The Officers of reserve are drawn from two sources, viz., from the active army and from one-year volunteers. Officers of the active army who have served in the commissioned ranks for one year, may be transferred to the reserve, provided they are not liable for service with the colours for a longer period than the legal term. If they have completed ten years' service, it is optional with them to be attached either to the reserve or Landwehr. All Officers wishing to retire from the active reserve in time of peace, and to retain commissioned

rank, must bind themselves to serve as Officers in one or other of these, or with a depôt or local establishment, in the event of war, according to their physical capacities. This obligation lasts until the attainment of their sixtieth year, unless they should previously become unfit for any service. On transfer to the reserve they continue to be borne, according to their previous rank and seniority, on the Officers' roster of their former regiment or corps. They are bound to attend an annual muster, and are liable, like the men, to three trainings of four weeks each during their seven years' reserve service. The one-year volunteers, after two months' preliminary military drill in the ranks, undergo a six months' course of instruction in all branches of military service, and especially in the duties of reserve Officers. During the remainder of their twelve months' service they receive, concurrently with theoretical instruction, as above, practical instruction on parade and at manœuvres in the duties of non-commissioned officers and subalterns. A board of examination is assembled shortly before the expiration of their term, composed of a Brigadier as president, the Chief of the Staff, two Staff Officers of Division, and two Captains. The Officer instructor is in attendance, and reports in detail upon the instruction given and its results. After a searching examination, both theoretical and practical, the candidate is pronounced "well qualified," "qualified," or "unqualified." Those who are in the last category, who withdraw during the course of examination, or who only undergo the test for appointment as non-commissioned officers, may subsequently go up for the Officer's examination, but are not allowed to do so a second time, except under very special circumstances. On mobilization, the reserve is employed to fill up the 4th and 5th field battalions, which in peace time exist only in cadre, being stationed in the recruiting district of the regiment. A depôt battalion cadre is also maintained in peace time, which is filled up to war strength, so far as Officers are concerned, from the pension list and from such as having voluntarily retired are exempted, on account of age or infirmity, from other service. The number of combatant Officers required to raise the Army from the peace to the war establishment is 3,200, and if these do not suffice, the balance is to be provided for by promotion throughout the regiment.

The Officers for the Landwehr are drawn from the active army by transfer, from Officers of reserve who have completed their army service, or who on mobilization are posted from the reserve to the Landwehr; from the Landwehr itself, after passing a prescribed examination or for service in the field; and from Landwehr Officer aspirants. The latter is a new creation, and offers an extensive source for the provision of Landwehr Officers. Special schools were opened on the 1st December, 1878, at the chief military centres, and branches at other stations, numbering in all thirteen, for the purpose of training otherwise eligible candidates for the appointment of Landwehr Officers. The instruction is carried out on the same plan as the schools for one-year volunteers, by Landwehr Officers, or, where these are not forthcoming, by Officers of the regular army, who receive extra pay while so employed. The course lasts ten months, and is

concluded by an examination, upon the results of which depends the appointment or not of candidates to the rank of Landwehr Officer. All the Officers have to attend a yearly muster in each company district, and in the years when there is no battalion drill, the whole of the Officers of the district have to present themselves in uniform at a muster parade held at head-quarters. They rank with but below Officers of the active army. The same periodical training is obligatory as for the men.

Italy.—The experiences gained by Italy in the Campaign of 1866, led to her adoption, in 1871, of obligatory service. extending over a period of twelve years, divided, as in Germany, into several terms, spent with the colours, the reserve, and a militia respectively. The two former were intended for active service, whilst the third portion was to be reserved for home defence, the whole numbering about 900,000 men. The magnitude, however, of the forces successively brought into the field by Germany in 1870–71 showed this force to be comparatively small, and an amended law was introduced a few years later, in 1875, by which it was proposed to provide a force of over two millions of men. By it the mobile militia previously created is replaced in its defensive *rôle* by a newly formed territorial militia, and is set free to serve as a second army in support of the active and reserve forces, which combined form the first army.

Obligation to military service commences, under the new law, at the age of twenty-one, and lasts nineteen years. Each contingent is divided into three categories, the first of which averages about 65,000 men, the second 52,000, the third 57,000, or in all 174,000 men. The soldiers of the first category have different liabilities according to the arm to which they are allotted. Those belonging to the infantry, artillery, and engineers serve nine years in the permanent army (of which three are spent with the colours, and six on furlough, forming thus a reserve), three years in the mobile militia, and the remainder of their service, seven years, in the territorial militia. If joining the cavalry they serve the same time in the permanent army, but five years are spent with the regiment in place of three, and after the expiration of the nine years they are drafted direct to the territorial militia, in which they complete the rest of the service to which they are liable. The soldiers of the second category are borne for five years with the regular army, and for four years with the mobile militia, as a separate or recruiting reserve to fill vacancies, after which they are drafted to the territorial army, continuing to belong to it for ten years. They have received, hitherto, excepting in 1877 and 1878, a training of from forty to fifty days, but arrangements have been now made for this being extended to ninety days. Apart from this, they are not liable to be called up in time of peace. The men of the third category are such as are exempted from service except in time of war, on account of family reasons. They enter the territorial army direct, and remain in it the whole nineteen years during which their liability continues. The permanent army and the mobile militia are already nearly complete as laid down by the new law, having had the benefit of the previous Law of 1871,

which was not interfered with, and they number, including their recruiting reserves, 646,138 and 258,002 respectively, exclusive of Officers, or in all 904,140 men. With the territorial militia it is not so, for, owing to the Law of 1875 not having been made retrospective, it cannot produce its full effect for nineteen years, or until 1894, though it will have done so to a great extent ten years earlier. At the present moment it numbers about 580,000, but in 1884 it should include about 1,250,000 men.

The training of the whole of these forces has hitherto been insufficient, and must probably remain so on account of financial considerations. Of the permanent army it has been customary to dismiss a large number of men to permanent furlough a year, and in many cases two, before the expiration of their regular term with the colours. Of the recruiting reserve, numbering 200,092 men, there are over 96,000 who have received no training whatever, while that of the remainder has been limited to fifty, and in most cases to forty days. In case of a mobilization they would be called out as soon as possible and drilled at the district head-quarters, but nothing could be done in this way until the mobilization of the army of the first line at least had been completed, for these districts play a very important part in the operation. Only twelve days are allowed for the training of this reserve, which would have to be commenced from the beginning, and it must take some weeks to teach them even the rudiments of drill. If future campaigns should prove as rapid in their decisions as some of the latest examples we have had, these men will either have to be sent to the front, with a most inadequate training, or else they will not be in time to be utilized at all. But in any case no amount of training at the district head-quarters will supply the place of a previous service of some duration with the colours. As has been remarked, even the limited training which it has been customary to give them has of late years been dispensed with on several occasions, but there is a prospect now of this training being resumed and the period of it extended to ninety days, or double what it has hitherto been.

The mobile militia, although created by the Law of 1871, received its first organic formation at the commencement of 1875, and having been unaffected by the law of the same year, it has continued quietly to develop since then. It is entirely recruited from men whose term of service with the active army has expired, and should, therefore, be composed exclusively of trained men. This result, however, has not at present been attained, for, according to the formations laid down by ministerial instructions of July, 1877, 137,934 men are required to complete the ten divisions into which the force is to be formed. The strength of the militia is, however, considerably below this, and the deficiency would have to be supplied by men from the second category forming its recruiting reserve, who have only had forty to fifty days' drill. By the time that the twelve years required to complete the working of the 1871 Law shall have expired, in 1883, this defect will have been remedied and the whole force will be composed of trained men. The organization is excellent in every detail,

but, unfortunately, as yet no periodical training has been provided for, and no means are at hand to test its practical working. Apart from this, there is no reason why it should not be as efficient a force as the German Landwehr, upon which its formation is based. So long, however, as a total absence of drill and periodical training is continued, it cannot possibly be compared with it, and must, in case of mobilization, be found sadly wanting in the consolidation which gives such power to the German force. As with the active army, the men of the second category, who form the recruiting reserve of the mobile militia, are wanting in training, and cannot be looked upon as of much more value than totally raw material.

The territorial militia has at present no regular organization, and, like the mobile militia, no provision has as yet been made for drill. Though its strength will eventually exceed a million of men, when complete, which will not be until 1894, it is not proposed to utilize primarily more than 300,000 for territorial defence, and this number of trained men is already attained.

We find, therefore, that a very respectable force of men, even when compared with the enormous armaments of the present day, are available for field service and home defence, and that the organization is all that can be desired under the former head at least. Unfortunately, though, a fatal element of weakness is introduced by the incompleteness of the training afforded. Apart from the active army, no one section receives the drill and exercise required to render it complete, and the considerable forces under the head of recruiting reserves are almost entirely deficient of training.

The officering of the several classes of the first and second armies, which have been enumerated, is provided for by the maintenance of no less than six different lists, whilst that of the territorial militia has not as yet been dealt with separately.

These several categories are as follows:—

1. Officers of the active army who are serving.
2. Officers of the active army at disposal.
3. Officers of the active army who are supernumerary.

These three are destined exclusively to complete the first army on mobilization, and to fill up vacancies occurring, should there be any balance remaining over, and in exceptional cases for service with mobile militia.

4. Officers of the mobile militia.
5. Officers of the mobile militia who are supernumerary.

These two classes are allotted to the second army for the same purposes.

6. Reserve of Officers.

The Officers in this list are for territorial service and garrison duty. The active army derives its Officers almost entirely from the Military College at Modena. Besides the ordinary cadets, who receive their primary training there, separate classes are formed from non-commissioned officers. These must have served in a regiment for at least two years, with the rank of sergeant, and they must be certified to possess the general qualifications required for the position of Officer.

The Officers supernumerary to the active army are obtained from several sources. All those allowed to retire at their own request during their tenure of regular service are drafted to this list. Sergeants may also be promoted supernumerary Officers on the expiration of twelve years' army service, provided they have borne during this time an irreproachable character, and that their age does not exceed forty-five years. The greater number of Officers upon this list is, however, derived from one-year volunteers, which has hitherto been a great source of weakness in the cadres. In July, 1877, of the total number of 1,868 Officers, no fewer than 1,769 were Sub-Lieutenants obtained almost entirely from this class. The institution of these one-year volunteers has become, from the institution of obligatory service, a necessity which has been recognized in all Continental armies. But upon the manner in which their creation is regulated depends entirely whether they become a valuable unit in the corps of Officers, or whether they are, on the contrary, an element of weakness. As has already been pointed out, when discussing the reserve Officers of the French Army, Germany has succeeded in regulating the conditions of entry of one-year volunteers in such a manner as to ensure the exclusion of all but well-educated and really superior young men. Unfortunately, this was not, for many years at least, appreciated in Italy, though by the Law of 1875 it has sought to rectify this by the introduction of rules based upon the principles in force in Germany. Until these came into practice a few years ago, it was in the power of all to escape army service in the first category by the payment of about 100*l*. This ensured their transfer to the second category, entailing no further payment, and only a period of training extending over forty days. As a consequence of this, those who could afford it, a large proportion of whom were men of superior education and position, purchased exemption, thus withdrawing the very individuals required. By the Law of 1875, this grave defect was remedied, and the rules for the entry of one-year volunteers were approximated to those of Germany. Amongst these, the most important introduced was one which required candidates to produce a certificate of study from a university or superior school, by which it hoped to ensure a high educational standard.

It has been found, however, that such a restriction tended to still further reduce the number of candidates who presented themselves, and it was withdrawn in 1878. In its place an educational examination has been introduced, which, without being so extended as that in force in Germany, will give, if strictly carried out, a fair guarantee of a sound elementary education. In addition to these improvements, a more thorough training has been given during service, and a higher military examination is demanded on its termination.

In July, 1878, the permanent army was 750 Officers short of the establishment, of which 600 belonged to the infantry, and as the number annually entering does not exceed 300, it is barely sufficient to make up for vacancies occurring. To supply this deficiency, therefore, recourse must sooner or later be had to the supernumerary list, but, as will be seen, this is not at present in a position to furnish them. At the

commencement of 1879 there were in all on this list 2,171 Officers, of whom 1,594 were infantry. But from these a fifth Officer per company has to be provided throughout the Army on mobilization, which would require no less than 1,156 Officers, and leave only a balance of 438, or 312 short of the number required to complete the first army.

The mobile militia is officered in the main part by those passing into it from the active army, but these are altogether insufficient to supply its wants; and as a great number of these are one-year volunteers who have virtually received no training, a large proportion of the Officers are sadly inefficient. In 1877 there was a total of 2,242 Officers, but the infantry alone require considerably more than this, as will be seen by the following estimate:—For the ten divisions, viz., 10 Lieutenant-Generals, 20 Major-Generals, 40 Regimental Commanders, 40 Adjutant-Majors, 149 Battalion Commanders, 149 Adjutant-Majors of Battalion, 634 Captains, 2,776 subalterns, or in all 3,818 Officers.

The actual numbers available, however, at the beginning of 1879 belonging to the infantry were 49 superior Officers, 188 Captains, and 1,869 subalterns (including 279, the whole of the supernumerary list), in all 2,106, or 1,712 short of the requirements. Thus in round numbers there are only available about one-half of the requirements, and though provision is made annually for filling the vacancies in the higher ranks in case of mobilization by transfer from the reserve list and the active army, it is not apparent from whence the junior ranks are to be obtained, nor how the vacancies caused in the active army are to be filled. The reserve list comprised, in 1877, a total of 1,996 Officers, amongst whom were 17 Lieutenant-Generals, 61 Major-Generals, 78 Colonels, 167 Lieutenant-Colonels, 482 Majors, 444 Captains, and 747 subalterns; and from it would probably be taken most of the superior Officers required. But the junior Officers, apart from their being wanted for other duties, are generally of an advanced age, fitting them rather for territorial and garrison work than for active service in the field with companies.

On this reserve list are borne all Officers who have retired and are in receipt of a pension, and they remain upon it at the disposal of Government, irrespective of age, so long as they are physically capable of performing service of any description. By a law of 1877, Officers are transferred to this list also from the mobile militia when they become unfitted for further active service. Their obligatory service is limited to garrison and territorial duties, but with their own consent they may be employed in the mobile militia, and many of the superior Officers would no doubt be so in case of mobilization.

Considering the time the men have been away from the colours when they join the mobile militia, which in the infantry is six and often seven years, during which period they have undergone no training, they cannot be expected to be very efficient even upon joining. If we add to this, that while in this militia they are not called out for drill, and that, even if called out, they would only have about one-half of their complement of Officers, we can understand the complaints that have been made as to the unreality of this force. Until the men join-

ing it have had their military efficiency maintained by periodical drills and manœuvres, and until the several classes can be called up in the same manner during their service in the militia, the efficiency of the men composing it must be very inferior. But beyond rectifying this defect, it is absolutely necessary that the cadres be complete for the formations fixed by law before the force as a body can be looked upon as real. Although the question of Officers remains to be dealt with, an important step has lately been taken towards providing sergeants for the militia, which was previously almost totally unprovided with them. In the active army it is a condition of the promotion of corporal-majors to the rank of sergeant that they shall engage for a service of eight years in that rank. As a recompense for this lengthened service, they are transferred on its termination direct to the territorial militia, and their services are entirely lost to the mobile militia, where they are more especially required. Consequently the latter had no sergeants but such of the one-year volunteers as had been transferred to it in that grade, a number quite insufficient for its wants and extremely inefficient as well. By an order, however, of November, 1879, provision is made for the best qualified corporal-majors to be promoted to sergeant on the expiration of their service with the active army in the proportion of one per company in each class.

(*To be continued.*)

ON THE EMPLOYMENT OF TORPEDO-BOATS AGAINST SHIPS.

By Lieutenant Chaband Arnault.

(Translated from the "Révue Maritime et Coloniale." By Lieutenant E. Meryon, R.N.)

At the end of an article published in the "Révue" for May, 1874, entitled, "Heavy Guns, Armour Plating, and the Ram, in Naval "Engagements," we wrote the following lines:—"We leave aside the "torpedo, because it has never yet figured in engagements between "ships, and we wish to argue, not on the results of experiments, "more or less conclusive, made in time of peace, but solely on the "results of war during the last ten or fifteen years." The Turco-Russian War, which has just been concluded, has given us now the means of applying a similar process to the study of torpedo warfare, employed, not, it is true, as a weapon by seagoing ships, but simply as an engine of destruction used by small steamboats. Relying on the Russian reports, M. le Commandant Chardonneau has published, in the "Révue," very interesting accounts of the principal naval actions fought by the boat-torpedoists of the Czar's fleet.[1] It is a matter of great regret that we are unable to study the account of the same

[1] A translation of these accounts has been published in the Journal of the Royal United Service Institution, No. XCVI, p. 735, and No. XCVIII, p. 1019.

occurrences in the official reports addressed to the Turkish Government.[1] We have, however, obtained some information from the latter source, which we shall not fail to make use of. Besides these, the Civil War in America offers two or three naval engagements in which torpedo-boats played an important part; we give the particulars of these, before describing those to which the Turco-Russian War gave rise.

Our work is thus divided into two parts: the first consists of the recital of the bare facts useful for us to know; in the second we shall endeavour to throw some light on the lessons which may be drawn from them.

I.

(I.) The destruction of the "Houssatonic," on the night of the 17th February, 1864.—In the course of the year 1863, the Confederates built several boats, taking more or less the cigar form, and known in America by the name of "Davids." These boats were intended to attack the Federal vessels with spar torpedoes. One of them, built at Charleston, had the power of sinking herself completely at the moment of attack. Her propeller was a screw, worked by hand, by a crew of eight men. During her first cruize, under the orders of Lieutenant Payne, an enemy's vessel passed close to her without noticing her; the swell raised by the paddles of this craft sank the "David," and Payne alone, of all the crew, saved himself. This intrepid Officer did not lose heart, and he persuaded eight sailors to follow him again in his boat when she was recovered. A squall of wind produced an accident similar to the former one. Payne and two blue-jackets escaped death. The boat, again picked up, had some novel experiences. At the intended moment she dived, but never came up again, and Payne perished this time with all his crew. And even after three such catastrophes, a Lieutenant Dixon was able to find eight men sufficiently devoted to man the same boat when she was fished up from the bottom of the River Cooper!

"On the 17th February," writes the author of several interesting remarks on the Civil War, "the Federal corvette "Houssatonic" was "at anchor off Charleston, on the outer line of the blockade; it was "dark when, about 8.45 P.M., the Officer of the watch perceived some-"thing moving in the water towards the ship, about 100 yards "distant. It came straight towards the ship, and in two minutes "was alongside. During this time the cable was slipped, the engines "moved astern, and the crew called to quarters. About one minute "later the explosion took place, and the ship, going down by the stern, "heeled over to port, and sank. Happily the weather was fine and "the water shallow. The crew, with the exception of two Officers "and some men who were drowned, saved themselves in the rigging, "and were rescued by the boats of the 'Canandaigna.'"

It was the heroic Dixon who thus inaugurated, in naval engage-

[1] Though no official Turkish reports have been published, Hobart Pasha, commanding the Turkish Fleet in the Black Sea, has printed in vol. cxxvii of the "North American Review," 1878, some notes on the occurrences in the late war. His statements differ very much from the Russian accounts.—ED.

ments, the *rôle* of the torpedo carried at the end of a spar. His submarine boat disappeared with all its crew.

(II.) Unsuccessful night attack on some Federal frigates.—"Other "unsuccessful efforts," continues the author whom we have already quoted, "were made by the Confederates against the men-of-war of "the Union. The first was directed against the ironclad frigate "'New Ironsides,' by a rebel Lieutenant, who, in a small cigar-shaped "boat, proceeded to attack her in the middle of the night, when off "Charleston. Although he got alongside without being discovered, "and although the explosion was effected, there was no further damage "done than the death of the Officer of the watch of the 'Ironsides' "and the loss of the torpedo-boat, which was sunk by the mass of "water thrown up by herself. The frigates 'Minnesota,' 'Wabash,' "and 'Memphis,' were successively attacked by cigar-shaped torpedo-"boats, but they escaped, owing to the watchfulness of those on board."

(III.) Destruction of the "Albemarle" (night of the 27th October, 1864).—Towards the close of the year 1864, the town of Plymouth, on the River Roanoke, was in possession of the Confederates, but besieged by the Federal troops. A Confederate ram, the "Albemarle," defended it against all attacks from the river side. This vessel was secured to a quay, under the double protection of a battery of guns and a stockade of floating branches of timber, which formed a circle about 10 yards from her. A young Officer of the Federal navy, Lieutenant Cushing volunteered to attempt the destruction of the "Albemarle" by mean, of a boat fitted with a spar torpedo. On the night of the 27th October, he ascended the Roanoke, and was received, on approaching the ram, by a brisk fire of musketry; his boat, however, going at full speed, struck on the stockade. Cushing himself worked the moveable spar of his torpedo, placed it beneath the side of the "Albemarle," and fired it by means of a friction tube. The explosion, or perhaps a shot from the ram, sank the Federal boat, but the "Albemarle" went down almost immediately, and Lieutenant Cushing, who saved himself by swimming, succeeded in rejoining the Federal Army through the woods.

Such were the several very noteworthy engagements which gave rise, during the American War, to the employment of torpedoes as offensive weapons by boats. We shall now recount the similar acts which signalised the last war between Russia and Turkey.

At the commencement of hostilities the Turks had, on the Danube, 3 monitors, 5 ironclad gunboats, and 6 wooden gunboats; in the Black Sea, 2 frigates and 8 ironclad corvettes, besides a certain number of wooden ships. The Russians could oppose no respectable man-of-war to this numerous fleet, but they possessed, in the Black Sea ports, 15 torpedo-boats, mostly of the Thorneycroft type, with silent engines, very light and fast, and built in water-tight compartments. A screw steamer, the "Constantin," handed over to the Government by a maritime Company of Odessa, was arranged to carry, and to hoist up rapidly, under massive boomkins, four of these boats. The Russians also launched on the Danube quite a flotilla of torpedo-boats, but the majority of these latter were ordinary steam launches fitted with a spar torpedo over the bows.

(IV.) First affair of Batoum (night of 12th May, 1877).—At ten o'clock in the evening, the "Constantin" being seven miles from Batoum, lowered her four boats, which immediately steered for the port. On arriving there, the "Tchesmé," commanded by Lieutenant Zatzarennyi, was ahead of the other Russian boats by three or four cables' lengths; he was armed with a towing torpedo. Zatzarennyi, observing an ironclad moored at the head of the bay, cleverly manœuvred his boat and succeeded in striking with his torpedo the stern of the vessel. No explosion occurred. We do not know the exact type of the "diverging" torpedo employed by the Russians, but it appears that the towing conducting-wire, which was fouled for a moment in the screw of the "Tchesmé," suffered a denudation, which prevented the electric current from passing and from lighting the primer. The Turks, however, had taken the alarm, their shore batteries, as well as their ships, opened such a brisk fire of artillery and musketry, that the torpedo boats thought it best to be off with all speed. The "Tchesmé" and the "Sinope" reached the neighbouring harbour of Poti, the other two boats rejoining the "Constantin."

(V.) Destruction of the "Seïfé" (night of the 25th May, 1877).—Three Turkish ships were at anchor, with steam up, in the arm of the Danube which passes the town of Matchin, the double-turreted monitor "Seïfé," an ironclad gunboat, and a wooden ship. No obstructions protected them, but two guard-boats watched them, one at a short distance from the "Seïfé," the other near the ironclad gunboat. Four Russian torpedo-boats, from the neighbouring town of Braila, steamed up the Matchin arm, to attack the Ottoman squadron. They were ordinary steam launches, whose engines and crew, composed of about a dozen sailors, were protected, with the exception of the man at the tiller, by metallic roofing; each of them being armed with a torpedo carried at the bow, containing a large charge of gunpowder and which could be immersed to a depth of 10 feet, and fired electrically either by contact or by will. The sky was overcast, a slight mist hung about the river, but the night was not very dark. The Russian boats crept along the banks of the river, and as their engines were noisy, they went slowly so as to make as little noise as possible. The Turkish Officer, who commanded the "Seïfé's" boat, perceived them, but lost his head, and pulled off as fast as possible instead of alarming his compatriots. It was then half-past two in the morning. Arrived within a cable's length of the "Seïfé," Lieutenant Doubaroff, who commanded the Russian boats, put his boat, the "Czarwitch," at full speed, and was hailed and made out by the Turkish sentries. His torpedo struck the keel of the "Seïfé" under the overhanging part of the stern and exploded by contact. The "Czarwitch," which the fall of water had three-quarters filled, hauled off as quickly as possible under the fire of musketry from the monitor. The latter began to sink astern, but so slowly that at the end of ten minutes Doubaroff ordered the "Xenia" to attack her. Lieutenant Chestakoff, who commanded this boat, took the "Seïfé" broadside on, and exploded his torpedo by hand. He experienced some difficulty in getting away, as the screw of the "Xenia" was

fouled by some of the *débris* arising from the two explosions. Happily the "Seïfé," which had only been able to fire two shots, then sank very rapidly until the moment of her disappearance, her brave crew never ceasing to keep up the fire from their rifles. The other two Turkish ships, slipping their cables, had opened a well-sustained fire of artillery and rifles. A bullet pierced the hull of one of the two boats which had been left in reserve. This boat was obliged to beach herself on the bank, but quickly stopped the leak, and was able to follow the other boats of Doubaroff in their retreat. This fine affair cost the Russians none killed nor wounded.

(VI.) Affair off Sulina (night of 10th June, 1877).—In consequence of the feeling caused by the loss of the "Seïfé," the Commander-in-Chief of the Turkish Fleet, Hobart Pasha, ordered the vessels under his command to observe the following rules:—1st. To keep one watch under arms at their quarters all night. 2nd. To constantly patrol, by boats under steam, or, in default of these, by boats under oars, the neighbourhood of the vessel. 3rd. To surround the latter by obstacles capable of stopping the advance of a torpedo-boat. All these measures of prudence were rigorously observed by the crews of three armoured corvettes and a gunboat at anchor before Sulina on the night of the 10th June. The obstacles which surrounded these vessels consisted of ropes, arranged parallel to each other like clothes-lines, stretched between two boats which were kept in their places by strong anchors, and supported at intervals by little buoys, the upper part of this system coming level with the top of the water, though keeping out of sight. The Russians affirm that one of the Turkish ships was under weigh, but the Turks do not mention this circumstance. The ironclad corvette "Idjalick" was anchored at the head of the squadron.

The "Constantin" had left Odessa on the 10th June, with three torpedo-boats hoisted to her davits, and three more in tow, and stopped the following night when five miles from Sulina. At half-past one in the morning, the boats, divided into two groups, steered towards the port. At their head was the "Tchesmé," commanded by Zatzarennyi, and armed with a "diverging" torpedo; their boats Nos. 1 and 2, under the orders of Lieutenants Poustchine and Rojdestoonski. The night was so dark that in spite of the precautions taken by the Turks, the Russian boats arrived within 100 yards of their ships without being observed. Zatzarennyi made a sweep to bring his "diverging" torpedo to bear against the "Idjalick," but his towing conducting-wires fouled the screw of the "Tchesmé," and she was obliged from that time to cease taking part in the action.

According to the account of M. Chardonneau, the torpedo-boat No. 2 attacked the "Idjalick," whilst No. 1 advanced on another vessel, but all the accounts from Turkish sources agree in pointing out the "Idjalick" as having been the adversary of Lieutenant Poustchine, and besides, none of them say that any other ship had to repulse a Russian attack. It is, therefore, nearly certain that the "Idjalick" was the only antagonist of boats Nos. 1 and 2. The latter, going at full speed, cleared the obstacle round the Turkish

ship, and her torpedo exploded on contact; it is probable that it struck some obstacle before touching the bottom of the "Idjalick," or was struck by a projectile which ignited its priming, since this explosion produced no damage to the enemy's ship. The Turks, in their reports, do not even mention it. However it may have been caused, the water from it filled the fore compartment of boat No. 2, and she, being thus brought down by the head, was able to clear the obstacles and free herself by going astern. For some minutes the Turks had opened a general fire of artillery and musketry, it was then that No. 1, stopped at first by the ropes of the obstruction, succeeded in clearing it. Lieutenant Poustchine was standing by to fire the torpedo himself if contact did not effect it, but the explosion took place in an unexpected manner before the boat's spar touched the enemy's bottom. The "Idjalick" only suffered some slight damages above water. It appeared that, excited by the brisk fire of the Turks, the bluejacket charged with immersing the torpedo had failed in his work; the torpedo was on the surface of the water, and was struck by a projectile which exploded it. Lieutenant Poustchine disengaged himself, but his boat had suffered such damages that they were obliged to abandon her, and this brave Officer and the six men who accompanied him were kept afloat by their life-belts; at daybreak they were picked up by the Turkish boats.

The second group of Russian torpedo-boats, who had taken no part in the action, the "Tchesmé" and No. 2, rejoined the "Constantin," without the loss of a man.

(VII.) Day affair near Rustchuk (20th June, 1877).—With the intention of closing the navigation of the Danube to the Turkish ships, the Russians had adopted the plan of placing lines of mines in several places. On the morning of 20th June, six of their boats were occupied in arranging such an obstacle, near Rustchuk, when a Turkish ironclad from this place obliged them to take refuge amongst the reeds which border the river. The boat "Choutka," armed with a spar torpedo, and commanded by Lieutenant Skrydloff, started at full speed to intercept the course of the Turkish ship, in face of a hail of projectiles which fell around him, but the torpedo would not explode since its conducting wires had been cut in two places by bullets, and at this moment the bow of the "Choutka" was pierced by a bullet or case shot; the boat, however, going at full speed succeeded in escaping. Skrydloff and four of his companions were wounded.

(VIII.) Day affair near Nicopolis (23rd June, 1877).—During the course of this day, a Turkish monitor, commanded by an English Officer, left Nicopolis and proceeded down the Danube. Two steam boats armed with spar torpedoes waited for her as she passed, hiding themselves behind a little island. They darted at her at full speed. The monitor let fall rapidly round her side nets hung to booms, each one carrying a torpedo at its extremity, opening at the same time a lively fire of artillery and musketry. One of the Russian boats, the "Mina," had the wires of her torpedoes cut, and suffered such damages as obliged her to haul off. The other, the "Choutka," commanded by Niloff, vainly struggled to reach the hull of his enemy;

stopped by the booms and nets, pierced by a splinter of a shell, driven on shore by the monitor, she had great difficulty in saving herself. Although the crews of the Russian boats were protected by screens and iron shields, they had four or five wounded on that day.

(IX.) Affair at Soukhoum Kalé (night of 23rd August).—In reading the account of this engagement, which M. Chardonneau has given, we understood that the weapons employed by the Russian boats were spar torpedoes, one of these boats having been, in fact, half filled by the column of water from the explosion, and another sunk on approaching the Turkish ship, circumstances which would seem to indicate a very close attack; but a recent note by M. Chardonneau in the "Révue Maritime" of November, 1878, the report written by Captain Makaroff, of the "Constantin," as well as certain information from Turkish sources, seem to point out that the engines used by the Russians against the "Assar-i-Chefket" were "diverg-"ing" (towing) torpedoes.

Profiting by the night of the 23rd August, on which there was an eclipse of the moon, the "Constantin" stopped some six miles from Soukhoum Kalé. Some Turkish ironclads frequently moored before this place, which had recently fallen into the hands of the Sultan's troops. The four torpedo-boats of the "Constantin," headed by Lieutenant Zatzarennyi, started off with the intention of seizing the moment of the eclipse to enter the roads of Soukhoum. Towards half-past two in the morning, they perceived a Turkish ironclad at her anchorage. This was the corvette "Assar-i-Chefket," commanded by a brave Officer who had served some time in the English Navy. Hence there was good watch kept on board this ship, several boats were guarding her, and large fires lit on the shore illuminated all the roadstead. The Russian boats were, in consequence, early received by a lively fire from the "Assar-i-Chefket," and from the batteries of Soukhoum. The "Sinope" and the "Navarino" succeeded, nevertheless, if we are to believe the Officers commanding these boats, in exploding their torpedoes against the starboard side of the ironclad; the crew of a Turkish boat, hauled up alongside the "Assar-i-Chefket," was actually engaged for a moment in a hand-to-hand fight with the crew of the "Sinope," using their stretchers for arms. The "Navarino" was half filled with water by the columns from its torpedo. The Russian boats "Tchesmé" and "Mina" had steered towards another vessel, but, on making her out to be a merchant brig, they returned towards the "Assar-i-Chefket." The "Mina" exploded her torpedo against the starboard side of the ironclad, the "Tchesmé" attempted the same manœuvre, but as she approached "Assar-i-Chefket," the rolling of the latter, caused by the explosion of the "Mina's" torpedo, would have infallibly upset the boat. The Russian boats rejoined the "Constantin" with all speed. This attempt, they say, did not even cost them one wounded. Such is the account of the battle of Soukhoum from Russian sources. The "Assar-i-Chefket," however, only suffered slight damages, since after a stay at Constantinople, from 31st August to 12th September, she proceeded to cruise on the coasts of the Adriatic. Her captain

besides affirms that on the night of the 23rd August, only one of the torpedoes directed against him was fired, and that the explosion was not even effected when in contact.

(X.) Second affair of Batoum (night of the 27th December).—About ten o'clock in the evening the "Constantin" stopped five miles from Batoum and lowered her four torpedo-boats. The night was perfectly dark, a fine rain was falling, and the sea was only ruffled by a slight swell. Lieutenant Zatzarennyi, who had, as before, the command of the Russian boats, had some difficulty in finding his way in the darkness. However, about midnight he rounded the point of Batoum, and observed two large ironclads lying at single anchor, bows outwards, with their sterns moored to the shore. They noticed round them neither obstructions nor guard boats. Each of the Russian boats, "Tchesmé" and "Sinope," was armed with a Whitehead torpedo. The former carried her tube under the keel, the latter had hers arranged on a raft which she towed. Arrived at about seventy yards from the nearest Turkish ironclad, the two boats fired their torpedoes almost simultaneously; that of the "Tchesmé" exploded on the beam of the enemy's ship, that of the "Sinope" appeared to strike the stern of the ironclad. Their course would easily be followed on the surface of the water. Not till then did the ships and Turkish batteries open their fire on the Russian boats, who rejoined the "Constantin" with all speed. On the way the "Tchesmé" got rid of her ejection tube.

The Turkish ship attacked by the Russian boats had not suffered any serious damage. M. Chardonneau thinks that the "Tchesmé's" torpedo struck a rock, and that that of the "Sinope" did not explode. But may we not suppose that the Russian torpedoes exploded against under-water defences arranged by the Turks?

(XI.) Third attack at Batoum. Destruction of a Turkish war ship (night of 25th January, 1878).[1]—On the 25th January, at half-past eleven at night, Captain Makaroff again stopped five miles from Batoum, and sent off, under orders of Lieutenant Zatzarennyi, the two boats "Tchesmé" and "Sinope," each armed with Whitehead torpedoes. The weather was cloudy, but towards two in the morning, the moon rising, enabled the Russians to distinguish perfectly the ships moored before Batoum. One of these was an unarmoured cruiser of 1,200 or 1,500 tons, anchored at the head of the bay. The "Tchesmé" and the "Sinope" steered for her, and when about eighty yards from her beam, simultaneously fired their Whitehead torpedoes. Both exploded, and in less than three minutes the Turkish vessel entirely disappeared. The Russian boats successfully returned to the "Constantin."

II.

When acts of war are studied with the intention of deriving therefrom useful lessons, it is necessary to bear in mind the relative worth of the *personnel* and of the *matériel* which are employed

[1] According to Hobart Pasha, this never occurred; no ship was destroyed at this time and at this place.—ED.

in each encounter by the two belligerents. A victory gained by forces wisely organized over barbarians without discipline and unpossessed of deadly weapons, proves, from a military point of view, nothing; a success, which the troops or navy of one powerful nation owe to the employment of improved weapons, over adversaries equally powerful, nearly always furnishes examples well worth our consideration. Now, in the case which we are considering, it is certain that during the two last years of the great American War, that is, at the time of the destruction of the "Houssatonic" and of the "Albemarle," both Federals and Confederates possessed sailors, devoted up to the point of heroism, admirably cognisant of the details of their business, and furnished with weapons, often of most recent invention, which were not for that reason less formidable in their hands. We have only described the strange career of the submarine boat, commanded successively by Payne and Dixon, for the purpose of showing to what a pitch certain Americans then pushed their self-devotion.

In the Turco-Russian War, the adversaries whom we find opposed, equally merit the most serious consideration. The sailors of the Czar's fleet gave such decisive proofs of their bravery, audacity, and dexterity in handling their torpedo-boats that it would be superfluous here to extol their military virtues. Amongst the Turks, courage and devotion were not less remarkable. Recalling the destruction of the "Seïfé," until the moment when this monitor sank beneath the waves of the Danube, her intrepid defenders remained at their stations, pouring fire on the enemy! The Osmanli have, it is true, the reputation of keeping a bad look-out, but it should not be forgotten that during the later engagements, the Sultan's Navy was commanded by an English Officer of the greatest energy, Hobart Pasha, and that several of his ships were manœuvred by Captains of the same nationality. If the watch kept was defective at Matchin and in Batoum Roads, it was perfect, nevertheless, at Sulina and before Soukhoum Kalé. Thus, on the Danube, as well as in the Black Sea, the Turkish sailors were worthy foemen for the Russians.

This point once established, let us examine the actions which have been recounted. When, for the first time, the Americans employed the torpedo as the offensive weapon of boats, the latter seemed threatened with three dangers, which must inevitably, it was feared, cause their loss; if the direct effect of the "water-blow" did not stave in their bottoms; if the column thrown up by the explosion did not fill them, extinguishing the fires in their boilers, how were they to escape the hail of bullets, case-shot, and balls hurled by a watchful enemy? After the American War, after the destruction of the under-water boat commanded by Dixon, of the steam pinnace of Cushing, and of the "David," which tried to sink the "Ironsides," one certainly considered as sacrificed, beforehand, every torpedo-carrying boat which was despatched against an enemy's ship. Soon, however, numerous experiences came to show that a well-built torpedo-boat had nothing to fear from the shock, or from the thrown-up water. The fights at Matchin, Sulina, and Soukhoum Kalé thoroughly confirm these opinions. In fact, several of the boats

employed by the Russians, especially at Matchin, were far from presenting the guarantees of strength, which the beautiful boats specially constructed for torpedo work of the present day possess; none, however, of them were lost in consequence of the explosion of the torpedo which they carried. If the under-water boat of Lieutenant Dixon, and the "David," directed against the "Ironsides," were less fortunate, it is only to be attributed to their defective construction. In respect of Lieutenant Cushing's boat, it seems proved that its loss was caused by a shot from the "Albemarle."

The fire of guns, mitrailleuses, and rifles—these are the only real dangers which the torpedo-boats have to fear. Before the Russo-Turkish War, many seamen considered this risk as so serious, as to place in doubt the efficacy of a direct attack by boats armed with torpedoes, not only in the daytime against a vessel under weigh, but even at night against a vessel at anchor, if a good look-out were kept. We may believe now that a torpedo-boat, suitably built, does not run any exceptional danger. What, in fact, do the engagements just quoted teach us? Leaving aside boats which did not directly contribute to the results, whose crews, though present on the spot, were not actively engaged, neglecting also the American boats, which were victims only to their defective construction, we see that during the Turko-Russian and American Wars, sixteen torpedo-boats attacked enemy's vessels, with torpedoes of different descriptions. Now, of these sixteen boats, only two were destroyed, Lieutenant Cushing's pinnace and Lieutenant Poustchine's boat; the latter Officer even avows that he sank the boat himself, as an accident to the machinery, suffered after the engagement, would certainly have caused her to fall into the enemy's hands. Finally, several of the Russian attacks were made under most unfavourable circumstances; at Matchin, the "Xenia" was immovable for ten minutes under the fire of the "Seïfé," before attacking her; at the engagement at Sulina, boats Nos. 1 and 2, after having cleared the rope obstruction of the "Idjalick," occupied a relatively long time in disengaging themselves; before Soukhoum, the four boats which fought the "Assar-i-"Chefket" were made out at a considerable distance by the Turks. But these are nothing compared to the temerity which the Russians displayed during the affairs of Rustchuk and Nicopolis in broad daylight. Their Officers declare that at the latter of these actions the "Choutka" remained exposed for an hour to the fire of her adversary —a Turkish monitor, well armed and perfectly commanded—and, nevertheless, the "Choutka" succeeded in escaping, just as the "Mina" saved herself, and just as the boats employed at Matchin, Sulina, and Soukhoum Kalé escaped.

Some recent experiments have shown that a fast steam-launch, when pierced by one or more balls of the size of case-shot, is in no danger of sinking if it continue at high speed. This fact was confirmed, on different occasions, during the Russo-Turkish War. The "Choutka" was pierced at Rustchuk by a tolerably-sized projectile, and at Nicopolis by a grape-shot, and on both occasions kept herself afloat by going at full speed; near Matchin, the Russian boat

"Djiguite," of only moderate speed, received a bullet which pierced her stern; she had time, nevertheless, to beach herself, and was able to stop her leak in a few minutes.

Will not the crew of a torpedo-boat be more endangered than its hull, under the hail of bullets, grape and case, of the enemy? Examination of the different actions of the Turco-Russian War permits us again to answer this question. Taking, first, the night affairs; one wounded, such is the only loss suffered by the eleven torpedo-boats, which, exclusive of the boats themselves destroyed by one means or another, attacked different ships. In the engagements relatively prolonged at Matchin and Sulina, not a Russian was touched by the Turkish projectiles, and, for all that, several of the boats which Doubaroff and Zatzarennyi led were simply protected by screens, or by half-made roofings.

In each of the two day affairs, at Rustchuk and at Nicopolis, the assailants lost three or four wounded, but there again they were most imperfectly sheltered from the enemy's bullets. It may well be asked by what miracle the "Choutka" and her crew escaped, on the 23rd June, from the continued and prolonged firing of the monitor which they had so pluckily attacked. The artillerymen of the Turkish ships possibly were not very well drilled, but their riflemen have not usually been considered more inexpert than others, and we repeat that some of the Ottoman ships, pre-eminently those commanded by English Officers, proved in this war that they were capable of rendering good service.

Hence, and present experience shows it, the attack by day or by night of a well-built torpedo-boat against a vessel at anchor or under weigh does not present exceptional danger, either for the boat herself or for her crew.

In all coast wars, then, the employment of torpedo-boats is possible, but will it be really efficacious? The first part of this article has shown us that, out of fourteen attacks made by torpedo-boats, four have compassed the destruction of the ship, three have caused more or less serious damage to the enemy; the others appear to have been resultless. Now, in each of these affairs, the *matériel* and *personnel* exposed by the assailants to the fire of their enemy were hardly worth mentioning—ten or twenty men and one or more boats, worth together from 15,000 to 100,000 francs. And it was with forces small as these that they succeeded once in three times in destroying a ship manned by hundreds of men and the cost of replacing which was measured by millions of francs. Is not such a result sufficiently conclusive?

Let us notice also the conditions under which the pre-described attacks were made. The American torpedo-boats employed during the war were all, as we have already seen, singularly defective; many also of the Russian boats employed during the last war against the Turks left much to be desired. Have the torpedoes themselves which were employed by the assailants always given sufficient proofs of their efficacy? Not so; for the diverging torpedo of the "Tchesmé" would not even ignite in the first affair at Batoum, and was not able to be used at Sulina; again, at Soukhoum the explosion of these tor-

pedoes—probably of a similar description—only caused trifling damages to the "Assar-i-Chefket."

Another question—The Russian crews were excellent, but did they always manœuvre their torpedo-boats in the most judicious manner? During the first affair at Matchin four boats were under the orders of Lieutenant Zatzarennyi, but only one, the "Tchesmé," attempted to use her torpedo. This, then, we pronounce, was a very trifling attack. If the boats had together charged the Turkish ironclad which was attacked by the "Tchesmé," would the result have been the same? In the Danube, near Matchin, the intention of Doubaroff was to engage successively each of the enemy's ships, only using one boat at a time; from this cause three boats remained stationary for ten minutes under the fire of the Turks. Would it not have been more decisive, and less dangerous, to have attacked simultaneously the "Seïfé" with the "Czarwitch" and the "Xenia," and the armoured gunboat with the two other boats? It is enough to read the account of the fight at Sulina to see that in this case the plan of the Russian Officers was badly laid. Alone of all the night attacks made during the last war, those against the "Assar-i-Chefket" and the ship sunk before Batoum, were conducted in a faultless manner.

The affairs of Rustchuk and of Nicopolis deserve special attention. Such an attack, made in broad daylight, against a ship under weigh, has none of the same characteristics as a night attack. In the latter, the object of the assailants is to surprise an immovable vessel; one boat alone is sufficient to obtain the success; the destruction of the "Houssatonic" and the ruin of the "Albemarle" prove this incontestably. In the former case, on the contrary, it is necessary to fight an enemy on his guard, who sees his enemy approaching from afar, and can manœuvre quickly. Several boats should then unite their endeavours to divide his attention and augment their own chances of success. The attacks of the "Choutka" and "Mina" were therefore almost fatally condemned to failure, for, in an action like that of Rustchuk or Nicopolis, the co-operation of four boats, at the least, seemed necessary.

Thus, the torpedo-boats of America and of Russia have fought the majority of their actions under circumstances unfavourable to the efficacy of their weapons. This consideration causes the practical worth of an arm to stand forth, the record of the success of which on the field of battle is one overwhelming success to two checks.

We have noticed that in each of the affairs, at Rustchuk and at Nicopolis, the Russians suffered the loss of four or five wounded; in nearly all their night attacks, on the contrary, they did not lose a single seaman from the fire of the enemy. This fact quite proves that if ordinary boats may be utilized to surprise a vessel in the midst of darkness, a day attack requires special boats—fast, turning rapidly, presenting as small a target as possible to the enemy's gunners, and the crew of which should be absolutely protected against musketry. Grape and case can pierce the boat, but the experience gained at Rustchuk and Nicopolis shows us that if the engines remain unharmed, the boat escapes by keeping up a high speed. Hence great lightness

of hull, rapidity of movement and turning, small dimensions, musketry protection limited to the machinery and the fighting posts of the crew—such seem to us to be the principal requirements which boats specially built for torpedo fighting should fulfil.

Proceeding with our subject, we will now endeavour to determine what sort of torpedo, according to different circumstances, is best employed in boats.

During the first affair at Batoum, and before Sulina, the "Tchesmé" vainly endeavoured to use a "diverging torpedo."[1] If, as we believe, the "Assar-i-Chefket" was attacked by weapons of the same description, the inefficiency of the three explosions on this occasion will singularly enforce the arguments employed against their use. The Captain of the Turkish ironclad, we saw, affirms that one only of the Russian torpedoes exploded. There is nothing surprising in this contradiction between the relative accounts of the affair at Soukhoum. In the midst of darkness, of disturbance produced by the repeated discharges of heavy guns and of musketry, the assailants might very well have taken the explosion of a heavy gun for that of a torpedo blowing up at over 40 yards' distance from their boat, or those attacked might not even have heard the noise caused by this latter explosion. We do not know what was the exact method of igniting the torpedoes used against the "Assar-i-Chefket," but if we admit the accuracy of the Russian accounts, how are we to explain the inefficiency of the three explosions? Was the Turkish vessel protected by a ring of floating baulks of timber, kept at a slight distance from the hull, and against which the enemy's torpedoes struck and exploded? No report gives any support to this suggestion. From whatever cause it arose, the failure of the diverging torpedoes of the "Tchesmé" was sufficient to cause the rejection of these machines from use in boats. It was seen, in fact, that they might become for the assailants a cause of delay and of mischief, spoil the boat's manœuvring, and place her, in a word, in a most critical position under the fire of the enemy. Still, might not all these inconveniences be compensated for by very great chances of efficacy? Certainly not. The slightest floating protection will stop the diverging torpedo. Ropes stretched between two booms will throw off its towline and save the ship from all danger.

Reasoning, therefore, founded on the experience acquired during the Russian War, leads us to reject entirely the employment of diverging torpedoes from boats.

The actions which we have described at the commencement of this article present three complete successes out of six attacks made by means of the spar torpedo. But, as we have seen, the torpedo-boats employed by the Americans during the war were defective, and also the affairs of Rustchuk and Nicopolis were undertaken under conditions peculiarly unfavourable to the assailants. The destruction of the "Houssatonic" and of the "Seïfé" show that the spar torpedo is during the night a terribly effective weapon against vessels at anchor, unprotected by external defences. That of the "Albemarle" and the

[1] Evidently some form of Harvey torpedo, to be ignited by electricity.

fight off Sulina prove that such a defence is sometimes insufficient. We know, in fact, that during the night of the 10th of June the Russian boats of Lieutenants Rojdestoonski and Poustchine cleared the obstacles which surrounded the "Idjalick." That their torpedoes did not destroy this ship was because they were struck by a projectile, or met some obstacle inside the "stockade" arranged by the Turks. However, this stockade was possibly, in fact probably, the chief cause of the failure of the Russians, since it detained them for some minutes under the fire of the "Idjalick," and produced amongst them momentary disorder, which prevented them working their torpedoes with all the coolness desirable. Now, however rapidly the torpedo spar may be worked, there must always be the greatest difficulty in immersing the apparatus during the short space of time which the boat occupies in passing over the space which separates the vessel from her defences. In the day affair at Nicopolis it was similarly the nets and booms of the Turkish monitor which presented an impassable barrier to Lieutenant Niloff's boat. Relative powerlessness against a vessel defended by exterior obstacles, then, is the principal objection which can be made to the employment of the spar torpedo.

The Russians attribute the premature explosion of the two torpedoes which they were using against the "Idjalick" to their being struck by a projectile; at Rustchuk the torpedo of the "Choutka," at Nicopolis that of the "Mina," could not be fired, according to the Russian Officers, because their wires had been cut by bullets. Should we not rather look for the cause of these four failures in the defects of the weapons employed by the Russians, in the over hurry of their manœuvres, or in some blunders made when under the enemy's fire? In fact, experience proves that the impact of bullets or grape-shot cannot explode a torpedo, unless they act directly on its priming; and, also, two conducting wires are a very small target for musketry; besides, there is nothing to prevent these wires being protected by means of the torpedo spar itself. If we must give absolute confidence to the Russian reports, a most improbable chance brought about, on four different occasions, accidents, which the fallibility of men, even the most practical and the bravest, explains much better. Hence we cannot consider the damage to which the enemy's fire subjects the spar torpedo as a serious objection to their use.

We have only been able, unfortunately, to cite two actions in which the assailants used the Whitehead torpedo; one was a check, the other a complete success for the Russians. What actually occurred at that second affair of Batoum? M. Chardonneau believes that the "Tchesmé's" Whitehead struck a rock; since this torpedo was fired at only 70 yards from the Turkish ironclad, we must then believe that this ship was herself very close to the reef; the slightest change of position would have put her on shore. It is not probable that her Captain should have chosen, in the vast Bay of Batoum, such a perilous position. May we suppose that the Russian torpedo met some submarine defences arranged by the Turks? The latter were doubtless competent to attempt such a system of defence, but no accounts credit them with such an effort.

It is necessary to search elsewhere for the explanation of the Russian failure. When they attacked, the night was very dark, consequently they may have considerably misjudged the distance which separated them from the enemy. Every seaman knows that in profound darkness the loom of a large ship suddenly appearing presents a misleading idea of height and length. The Russian Officers profess to have followed on the water the track of the "Tchesmé's" torpedo on its way to the beam of Turkish ship, but the adjusting of a Whitehead torpedo is a most delicate operation; so that, in their path, these machines do not always follow a straight line. It is, therefore, very possible that the Russians fired their torpedoes at a much greater distance than 70 yards from the Turk, and that they, swerving slightly, passed astern of the vessel, and struck the reefs of the neighbouring shore. This supposition appears even more admissible, since from the reports of the Russian Officers, the "Sinope's" Whitehead took a direction towards the stern of the ironclad.

Besides, the methods adopted for discharging the torpedoes from the "Tchesmé" and from the "Sinope" were probably defective; a movable tube under the boat's bottom, or the expedient of an accompanying raft, do not seem to us to be very convenient arrangements for pointing a Whitehead. Did the Russians improve these arrangements before the third affair at Batoum? We do not know; but the rapidity with which the attacked Turkish ship sank would lead us to suppose that both the Whiteheads fired in this case by the "Tchesmé" and "Sinope" reached their destination.

We see that on the Danube the Russians made no attempt with the Whitehead. Rivers, and sea coasts with strong tides, and all estuaries with currents, are essentially unfavourable to the employment of these engines, even against vessels at anchor. Both the boats and the torpedoes find themselves, then, subject to too many exterior influences for pointing of the torpedo to be performed with accuracy; a rough sea renders also very ticklish, or even impossible, the discharge of a Whitehead, and finally the difference in density between salt water and fresh might possibly be a great obstacle to the employment on rivers of Whiteheads experimented on and regulated in a maritime port.[1] Thus, deviations arising from an incorrect estimate of distance, defective adjustment of the rudder, inaccurate pointing, and exterior influences affecting its direction or its depth of immersion, such are the gravest inherent difficulties in the use of Whitehead torpedoes from boats.

Based principally on the experience acquired in the Russo-Turkish War, the foregoing discussion permits us to define the circumstances which appear favourable either to the effective use of spar torpedoes or of the Whitehead torpedo; firstly, against ships at anchor, and secondly, when under weigh.

When a vessel is anchored in the middle of a strong stream, it is very difficult to establish a defence round her water-line, or even a

[1] *Note by Translator.*—This objection is slight, as all our Woolwich torpedoes are regulated in fresh water, the difference between their performance in that and in salt water being inappreciable.

good defensive arrangement of nets and spars from her hull. We have just seen that similar circumstances, above all, with a dark night and a rough sea, render also very uncertain the aim of a Whitehead. Spar torpedoes should then be employed by preference, by boats charged to attack; the darkness will also enable these latter to evade more easily than on a bright night the look-out of the patrol boats and of the enemy's sentries.

When, on the other hand, the night is not too dark, when the sea is calm, and the absence of current permits the attacked vessel to defend herself by exterior defences, the employment of Whiteheads presents good chances of success, which are unattainable for the spar torpedoes.

The opportunity of attacking a vessel under weigh by torpedo-boats may offer itself as well by day as by night. No engagement argues for or against the employment of Whiteheads under such circumstances; but the affair of Nicopolis shows that a ship of ordinary speed can protect herself effectively against the employment of spar torpedoes by an arrangement of nets and spars. The use of the Whitehead under such circumstances is thus naturally suggested. We must not forget, however, that the speed of the enemy's ship adds a considerable element to the external causes which render the aim from boats very uncertain. Summing up, it would appear wise to introduce into flotillas intended for coast defence some boats armed with spars, and some with Whitehead torpedoes.

In conclusion, we quote a simile the truth of which has struck us. The spar torpedo is the dagger which a determined man plunges into the body of an enemy who does not protect himself with a coat of mail; the Whitehead torpedo is the bullet which, easy to discharge from afar, kills the enemy in its path, but which very often strays uselessly far from its mark.

Till now, we have only examined the actions fought by the torpedo-boats from the point of view of the assailants, let us see if they offer us any useful hints as to the defence? That the "Minnesota," "Wabash," and the "Memphis" were neither sunk nor seriously damaged by the Confederate "Davids" was owing chiefly to the extreme watchfulness of their crews; but the "Houssatonic," which was on her guard, since she had slipped her cable at the moment of the explosion, was, nevertheless, destroyed by Lieutenant Dixon's boat. The Turkish ships moored at Matchin and before Soukhoum Kalé had patrol boats out, but yet the "Seïfé" was sunk, and the "Assar-i-Chefket" only escaped the same fate through the bad management of the weapons brought against her. One sees, therefore, that the most careful watchfulness is not always sufficient guarantee against the attack of torpedo-boats. All the actions which we have reviewed show equally, in a most decided manner, the inefficiency in these cases of a defence based solely on artillery and rifle fire. On the other hand, if the "Albemarle" was sunk in spite of the stockade around her, we have seen that simple ropes stretched round the "Idjalick" baulked the efforts of the Russians, and that the monitor attacked before Nicopolis probably owed her escape to the nets and spars extended from her hull. The objection is raised to the use of such systems of defence, of

the necessity of a ship liable to the attacks of torpedo-boats being always ready to get under weigh; but the example of the "Hous-"satonic" proves that this latter precaution is insufficient to save a ship from the attack of a fast torpedo-boat. Besides, need the getting under weigh be prohibited by a system of nets and booms arranged round the vessel? Decidedly not, since the Turkish monitor at Nicopolis used this species of defence while actually under weigh. Such a feat cannot have too much importance attached to it, which has demonstrated practically the possibility of defending, externally, the hull of a steamer under weigh; and, hence, the necessity of seriously studying this subject. We are well aware that in the open sea, even at slow speed, the employment of nets and spars would be impossible, but it is nearly always at mouths of rivers, in narrow passages, and in roadsteads, in generally calm water, that ships will have to defend themselves against the attacks of torpedo-boats.

In addition, or in default of spars and nets stretched from the hull, a ship at anchor can, under certain circumstances, protect herself effectively by means of "stockades" attached to boats or to buoys moored around her. It was thus that the Turkish stockade at Sulina was made that baffled the efforts of the Russian torpedo-boats. The Ottoman ships at Batoum were in excellent positions for following that example. Their bows fast to an anchor ahead, and their sterns moored to the shore, they had every facility for establishing a good stockade some yards from their hulls, which would have been practicably immovable. It is evident that in tideways, or variable winds, a ship swinging to her anchors could not adopt similar arrangements, in consequence of the too great room required for her movements.

Hence, the events of the Turco-Russian War seem to indicate the following measures as the most advantageous for the protection of a ship against the attacks of torpedo-boats, to be combined according to the different circumstances which present themselves. One watch of the crew to sleep at their quarters all the night; machine guns and guns of small calibre loaded and depressed in advance; steam up and cables ready to slip; a system of nets and booms extended from the ship; a stockade of the description of that employed by the Turks before Sulina; rowing boats protecting this stockade, armed with guns or machine guns; and, finally, at a distance of not less than 100 yards, one or more boats under steam, their object being to give the alarm, and yet more to rush with all speed on an enemy's boats, which might be preparing to use Whitehead torpedoes. A vessel thus prepared may not be invulnerable, but she would have, we believe, much the best chance on her side.

Conclusion.

In summing up, these are the conclusions to which we bring our examination of the engagements passed in review in the first part of this article.

1st. The attacks made by torpedo-boats during the American and Turco-Russian Wars were delivered under conditions such that their results ought to be taken into serious consideration, with the view of

extracting information. These results appear to establish the following points :—

2nd. An attack made against a ship by means of a torpedo-boat does not require more exceptional circumstances, nor more absolute devotion, than any other operation of naval war.

3rd. An attack of this description, where the assailant only risks forces relatively small, offers such chances of success that it should always be tried when the occasion presents itself.

4th. One single torpedo-boat, of moderately good quality, is sufficient to surprise at night a vessel at anchor ; a day attack, on a vessel under weigh, requires the co-operation of several torpedo-boats, especially built for the purpose.

5th. Under all circumstances where such boats, collected into a flotilla, have to attack one or more ships, their attacks should be simultaneous.

6th. The use of "diverging torpedoes" in boats should be discontinued.

7th. Spar torpedoes are usefully employed by boats attacking, on a very dark night or with a slightly agitated sea, a ship moored amongst strong currents, or which may be expected not to be protected by external defences.

8th. Whitehead torpedoes will be employed by preference when the night is comparatively clear, the sea very calm, the current slight, and when one may suppose the enemy's ship to be provided with obstacles.

9th. Against a vessel under weigh, the two species of torpedoes will both respectively find their value, according to circumstances. It would appear, then, to be best to combine, in a flotilla intended for the defence of harbours and roadsteads, both spar and Whitehead torpedo-boats.

10th. Whenever circumstances will permit, a ship at anchor should guarantee herself against the attack of torpedo-boats, not only by the help of a good watch on board and abroad, but also by obstacles attached to her, or by an independent stockade, or even by combining the two systems.

11th. Finally, in certain circumstances, a ship under weigh may defend herself advantageously against torpedo-boats by booms and nets.

It is necessary to add that we have not the slightest pretension to laying down here what are termed the principles of torpedo warfare. We have simply endeavoured to draw some useful information from the conscientious examination of the different sea fights in which torpedo-boats have taken part.

The torpedo is an arm too recent not to undergo, before long, transformations which may considerably modify its method of employment. In the meantime, let us profit by the lesson taught us by these seamen, the first who have used these redoubtable weapons of war.

THE UTILIZATION OF COLONIAL FORCES IN IMPERIAL DEFENCE.

(Read before the Toronto (Canada) Militia Institute, on Saturday 25th October, 1879.)

By Lieutenant-Colonel T. C. Scoble, Canadian Engineers.

The relations of Great Britain with her colonies are of a complex nature. With those having responsible government, she is bound more by the ties of kindred and affection, and that fervent loyalty which seems to be developed by expatriation, than by common interest. In fact, in many cases colonial and Imperial interests are of a most conflicting character. To colonies which are still in a state of tutelage, where the government is in the hands of Imperial officers, and the revenue and expenditure are under their control, the Empire is bound by common interest. To those colonies which have been planted for military or strategic reasons, the obligation is purely Imperial.

The colonies may therefore be classed as follows:—

1st. *Independent Colonies.*—Canada and Newfoundland, Australasia and the Cape Colonies.

2nd. *Governed Colonies.*—India, Ceylon, the West Indies, including Honduras and Guiana, the Mauritius and Straits Settlements.

3rd. *Military Colonies.*—Malta, Gibraltar, Aden, Hong Kong, Labuan, Cyprus, Fiji, the Bermudas, Sierra Leone, Gambia, Gold Coast, Ascension, Falkland Islands, St. Helena.

Assuming that each section of the British Empire is alike responsible for its share in a scheme of Imperial defence, according to its population and resources, it will be necessary that they shall be grouped geographically, the larger with the lesser, Great Britain forming the contral group, from which all the others radiate, as follows, viz.:—

Indian possessions, including Ceylon, the Straits Settlements, and Hong Kong.

African possessions, including Cape Colony, Natal, the Mauritius, St. Helena, and Ascension Island.

Australasian possessions, including Fiji, Labuan.

American possessions, including Canada, Newfoundland, the West Indies, Honduras, Guiana, and Bermuda.

The chief colonies in these groups, having responsible governments, should be communicated with, and advised of what was expected of them upon the outbreak of a war which threatened the Empire collectively. They should be called upon to furnish garrisons to each adjacent coaling station and naval depôt, of such strength as might be deemed advisable by a military commission employed in time of peace

for such a purpose. The forces so engaged should be drawn from the colonial militia, or, in the case of India, the standing army, and should be placed at the disposal of the Imperial Government for garrison duty during the continuance of the war. They should also garrison the military posts at present maintained within the limits of each colony, and such other points within the colony as might be deemed necessary by the military commission.

The troops they would be called upon to furnish under this arrangement would be as follows, viz. :—

India, for Aden, Straits, Ceylon, and Hong Kong	3,000 to 4,000
Canada, for Halifax and Bermuda	3,750 „ 5,000
West Indies, Barbadoes, and Jamaica	1,500 „ 2,000
Cape Colonies, for Mauritius, St. Helena, Ascension, &c.	1,500 „ 2,000
Australasia, for Fiji and Labuan	800 „ 1,000

By giving these points a fair share of naval assistance, by furnishing all necessary armaments and munitions of war, and by holding the colony in whose charge they were placed strictly responsible for the retention of the various posts, the Central Government would be left at leisure to administer affairs more nearly at home, and would have at its disposal at least 10,000 regular troops from the relieved garrisons.

But in addition to this measure, the Central and Colonial Governments should unite upon a plan by which each colony should bear its share in the Imperial defence. This could not be arranged by means of a money tax or subsidy, as most of the colonies are too much engaged in developing their internal resources to be able to afford such payments, but by means of a contingent of troops proportioned to their population and warlike character. Canada, with its population of 4,000,000, and a fighting strength of nearly 700,000, could, and no doubt would, most cheerfully furnish a contingent, independently of the garrisons before named, of say 10,000 men; Australasia, with an European population of 2,500,000, would doubtless furnish 5,000. The smallness of the European population at the Cape (some 320,000) and its exposed position would prevent their furnishing more than the contingent required for the defence of the colony; as would likewise be the case with the West Indies and the military colonies. But India could spare from her Indian troops man for man with the European soldiers which she retained, and still have the vast armies of the native Princes to draw upon as possible contingents, were the theatre of war to be in Eastern Europe or Asia.

To enter into the details of such a scheme would imply much time and space, and I shall therefore content myself with describing the share that Canada would bear in carrying it out.

Suppose that Great Britain has established in each of her great colonies a Royal Colonial Militia Reserve, the force being enlisted for six years, and being liable for service in the Army in case of war, with the distinction that they should not be drafted into line regiments, but serve together under their own Officers as a colonial contingent.

This force should be placed upon the same footing as the militia of Great Britain, being clothed, armed, equipped, and paid by the Imperial Government, and subject to being called out for drill for three or four weeks in each year, the men receiving in addition to their pay a bounty of 1*l.* per head per annum. To each regiment would be attached a permanent instructional staff and a sufficient depôt, the whole being subject to the inspection and supervision of the Officer commanding Her Majesty's troops in the colony.

We will take it for granted that Canada's quota is 10,000 men, who are distributed as follows:—

Ontario (3 regiments, 2 batteries, 1 company Engineers)	3,500
Quebec (2 ,, 2 ,, 1 ,,)	2,500
New Brunswick and Prince Edward Island (2 regiments)	2,000
Nova Scotia (2 regiments)	2,000
	10,000

There could be no difficulty in raising that number, as the 1st Class Militiamen of these four provinces numbered 238,555 in the enumeration of 1873 (see Appendix). Nor could the Canadian Government take exception to the enlistment of such a number, since for the past three years they have only drilled 20,000 of the 45,000 men provided for in the Militia Act. Of course, the advantages afforded in the Royal Colonial Reserve would attract to its ranks all the more adventurous and bolder spirits, with whom the possibility of foreign service and a more extended sphere of action than can be found in the active militia would be the inducements to enlist. In this way a *corps d'élite* would be formed; and by keeping up the standard of physique and character, the Canadian contingent would prove no discredit to its country. And what more suitable and acceptable contribution to the Imperial defence could be made than a division of Canadian soldiers?

If a colonial army reserve might with advantage be raised, how much more a colonial navy reserve! The chief factor in Imperial defence must necessarily be the Navy. Apart from its being the traditional bulwark of the British nation, is the fact that the supremacy of the seas is vitally necessary to Great Britain. Without that element the colonies would be impotent to assist, as their supplies of munitions of war would be cut off, and the people of Great Britain would starve, as they require to import annually fifteen-thirty-thirds of the food they require for the support of their 33,000,000 of inhabitants. Therefore, the supply lines must be kept open, and the Navy must do it. The comparative fighting power of the British Navy is given by a French authority as two-thirds greater than Germany, one-third greater than France, and six-sevenths greater than Russia. But how far is this total fighting strength available?

We are told, upon reliable naval authority, that it would take upwards of *two years* to put the steamers now out of commission into fighting trim. Of the total British steam navy there are:—

	Armoured.	Unarmoured.	Gunboats.
In commission	31	125	29
In reserve, repair, or building	31	77	37

That is to say, nearly one-half of the fleet of steam-vessels are immediately unavailable. We are also told that the number of seamen requisite to man the fleet is about 87,000, while there are only 57,000 available (taking all reserves into the calculation), leaving 30,000 men to be provided.

Now if a royal naval reserve were to be established in the colonies, and these men were to be trained on reserve vessels provided for the purpose, there would be found in war time at the head-quarters of each colonial station a sufficient number of trained seamen to man the vessels upon that station, thus releasing the Navy men for other duty.

In Canada there are registered 37,235 sailors. On the North American and West Indian station there are 20 war vessels, manned by 3,173 Officers and seamen. There could be no difficulty in procuring the crews for these vessels from amongst our hardy seafaring population; but, in addition, Canada owns 1,185 seagoing steam-vessels, to act as transports and supply vessels. A sufficient number of these vessels should be carefully surveyed and enrolled as "naval reserve "vessels," the Commander having instructions to proceed immediately upon the declaration of war to a harbour or rendezvous. There should be stored fittings and armaments designed for each vessel, and immediately available, so that no time should be lost in fitting for sea, having in view the special suitability of each vessel for cruising, transport, or supply purposes.

Having inaugurated these systems of army and navy reserves, let us suppose the immediate effect of a declaration of war so far as Canada is concerned.

First.—The Canadian Government calls for 5,000 active militia for garrison duty at Halifax, Bermuda, and Quebec. Simultaneously the Lieutenant-General Commanding in British North America orders the Royal Militia Reserve to report at Halifax.

The Admiral Commanding orders the Royal Naval Reserve to report at Halifax, assembling a portion of the North American squadron at that station, and a sufficient fleet of transports and fast cruizers to fit out and coal at the same place.

Let us say, then, that within twenty days we have assembled at Halifax:—

Regulars (relieved garrisons).....	5,000
Colonial Army Reserve.....	10,000
Colonial Navy Reserve	3,000
	18,000

who are ready for embarkation in the transports, and to sail for any destination.

We have the vessels, the crews, and the men necessary to carry out this scheme; what, then, is necessary in order to secure this state of preparation?

1st. A well digested scheme and a thorough understanding between the Colonial and Central Governments.

2nd. The establishment at each colonial station of a sufficient supply of arms and munitions of war to meet the requirements of the defined plan of operations.

3rd. The establishment of graving docks upon colonial stations, in order to secure the immediate repair of injured vessels.

4th. The establishment of properly garrisoned coaling stations upon each supply route for the use of cruizing squadrons. Coal might be supplied equally as well from the colonies as from England, although this does not seem to be the opinion of the Admiralty Board. It is a mystery to the uninitiated, however, why Nova Scotia cannot supply the North Atlantic squadrons—British Columbia the North Pacific—Natal the South Atlantic and Indian Oceans—New Zealand the South Pacific—and Labuan the China Sea. All that most of these places require are the means for the development of their mines.

5th. The selection in peace time of suitable fast steamers, owned by private shipowners, for cruizing and transport services. If the Captains of these vessels were commissioned as Navigating Commanders in the Naval Reserve they would have an interest in their work, their status would be defined, and they, with their crews, would be responsible for navigating the vessel. A combatant Navy Officer, with a fighting crew, would have to be placed upon each vessel, but the duties would not clash, as the latter would be engaged in the special duty of preparing his vessel for fighting or in fighting it. The proper armament for such vessels seems to be the 12-pr. rifled gun, which is light enough to be worked on any ocean steamer without its needing to be strengthened, and at the same time has sufficient penetration to pierce the side of any unarmoured vessel. Every steam supply vessel of the merchant navy should, in war time, carry from four to six of these guns, and their possession would enable them to bid defiance to any ordinary privateer or unarmoured vessel.

The above conditions being secured, I can conceive of no reason why the various colonies should not play an important part in Imperial defence. In the case of Canada it must be borne in mind that the Straits of Gibraltar are no farther from Halifax than Liverpool—and that Malta could be reached from Halifax almost as soon as from London. Conceive the advantage to Great Britain if an expedition of 15,000 men were known to be fully equipped and supplied with all the material of war, having its base of supplies and reinforcements in Canada, its transports, cruizers, and supply vessels, and the North American Squadron at hand to keep up communication with its base! Conceive that this expedition, complete within itself, could be launched against any part of the European coast within thirty days from a declaration of war! Consider the power which this knowledge would give the Commander-in-Chief, that he held a division in hand, complete in organization and equipment, with a separate base of supply and means of protecting that base, and that this division could be used in support, in reserve, or in diversion, and, if necessary, form a separate expedition for aggressive purposes!

The same rule applies to India, and, in a modified scale, to Australasia. India has already sent troops to Malta; if the theatre of war is to be in Asiatic Turkey or Egypt, her army could furnish the advance guard, from its proximity. The native army of India consists of 126,877. It is the opinion of General Upton, United States Army, that the whole of this force could be removed without danger. He says (p. 83, "Report upon the Armies of Asia and Europe"), "but without "aid from England, the railway system by itself is sufficient to enable "60,000 British troops to hold India almost indefinitely." Supposing that Bombay and Madras were each to furnish an army corps of mixed troops, leaving the Bengal establishment intact, there would still remain in the Bombay Presidency 9,000 men, and in Madras 18,000 men. Quite enough for garrisoning important points in those secure parts of the country.

These two army corps should be self-contained, and have their base in India, operating as an Indian contingent, under Officers who would understand the peculiar constitution and prejudices of the force.

But in addition to the native army of India there is a large military element to draw from in the armies of the native Princes, many of whom offered their services in anticipation of a war between England and Russia two years since. The total number of troops employed by native Princes is stated to be 300,000. Of these the

Nizam of Hyderabad employs ..	45,000..	725 guns.
Maharaja Sindia.....	20,000..	500 ,,
Gaekwa of Baroda.....	14,000..	30 ,,
Maharaja of Jaipur	14,000..	312 ,,
,, Odaipur.....	22,000..	538 ,,
,, Kathiawar.....	19,000..	508 ,,

Collectively, the native Chiefs command 5,252 guns, 9,390 trained artillerymen, 64,172 cavalry, and 241,063 infantry. Of course, many of these are *very* irregular soldiers, but if Persia or Afghanistan were to join with Russia in an invasion of India, these irregulars would fitly cope with the fierce Afghans, the cruel Persians, or the savage Tartars. It must not be forgotten that, but for the noble conduct of some of these native Chiefs, India would probably have been lost to us, temporarily at any rate, in 1858.

It is not impossible, although perhaps improbable, that Australia might be called upon to assist Canada. Practically, British Columbia is more accessible from Australia by sea than from the inhabited interior of Canada by land, if means of transit through the United States was denied to us. For a military expedition to cross the great plains and the Rocky Mountains, to traverse the wilds of British Columbia to reach Esquimault or Nanaimo, would be the work of months. For a similar expedition to reach the same point from New South Wales, Queensland, or New Zealand would only be a voyage of weeks. But, with a male population of nearly 35,000, British Columbia should be able to hold its own without outside assistance, were arms and stores furnished.

And this latter sentence leads to the most serious consideration of

all. If war were to break out immediately, in what position should we be in Canada as regards arms and stores?

Of field guns we have—

6 6-pr. Armstrong guns at Halifax.
2 7-pr. M.L.R.
60 9-pr. M.L.R.
76 3-, 6-, 9-, and 18-pr. smooth-bore.
15 12- and 24-pr. howitzers.

Of garrison guns we have—

423 12-, 18-, 24-, 32-, 56-, 68-pr. smooth-bore.
10 7-inch B.L.
4 7-inch M.L.
26 8-inch S.B.
21 64-32 Palliser guns converted.

Of naval guns—

102 carronades, 12-, 18-, 24-, 32-, 68-pr.

Of battery howitzers and mortars—

22 5½- and 8-inch howitzers.
53 8-, 10-, and 13-inch mortars.

Or a total of all kinds of 895.

The total quantity of powder in store for these guns is 204,108 lbs., or an average of about 30 rounds per gun.

We have a reserve of 21,000 Snider Enfield rifles, and 40,000 in the hands of the active militia. For these we have 7,692,390 ball cartridges, or 126 rounds per rifle. Besides these, there are 2,100 Martini-Henry rifles, and 466,060 ball cartridge, or 221 rounds per rifle.

Of shot and shell we have about 200 rounds for each serviceable gun.

Thus it will be seen that we have—

68 serviceable rifled field guns.
21 serviceable rifled garrison guns, with, say, 200 rounds per gun.
62,100 rifles, with an average of 125 rounds per rifle.

to arm a coast-line of 1,000 miles, and a militia 700,000 strong.

The rule in the Imperial service (see "Soldier's Pocket Book," page 47) is that, when on service, the proportion of gun ammunition is calculated at 600 rounds per gun, small-arm ammunition at 1,000 rounds per man of infantry, 500 of cavalry, and 250 for other corps.

We have tents for 40,000 men, and blankets for half that number.

Of course, the above figures do not include the Imperial stores at Halifax and Bermuda, which are doubtless well supplied so far as the wants of their garrisons are concerned. But the British Government should make Halifax a depôt for military stores to contain sufficient quantities to supplement the possible requirements of the Canadian Militia and to supply the Royal Colonial Reserve. Such a depôt would provide for the possibility of the supply from England being cut off for a time, and every requirement in order to mobilize a division of 15,000 men should be there. In addition, there should be at the naval depôt sufficient stores to arm and equip the cruizers and transports required for the division. All arrangements should point towards making the North American station independent of Great Britain, and having its base in Canada.

Decentralization is, and must be, the greatest safeguard to Britain in case of war. To carry all your eggs in one basket is proverbially unwise; to lock up all your warlike stores in one or two arsenals is the most shortsighted folly. The invasion of England cannot be assumed to be impossible. Owing to the power conferred by steam upon the transport service, an opposing nation might concentrate a force with great rapidity at any required point, and the collection of a sufficient fleet of transports within any suitable harbour would be a matter of little difficulty. "The power of (the enemy's) concentrating "a force before daylight upon any point, and throwing them upon "shore in two or three hours," was the knotty question discussed by the Royal Commission of 1860, and its possibility was conceded as beyond a doubt.

Therefore, the contingency of having all the stores locked up, and an enemy between them and your supports, should be provided against.

One word before concluding as to the constitution of the colonial reserves, both naval and military. To give them local characteristics they should be raised by companies in populous sections of the country, and recruits should, as far as possible, be drafted from the same section. Officers should likewise be local men, of approved character and military fitness. They should hold the Queen's commission, as in the militia of GreatBritain. The appointments should at first be provisional, contingent upon fitness, and afterwards confirmed. Promotion should go in the division. When called out for active service the period should be confined to the duration of the war, or to a term not exceeding three years. The pay and allowances when on service should be identical with those of the corresponding arms of the Imperial service, and when performing annual drill the same as in the militia of Great Britain, with a bounty of 1*l.* per head per annum in addition, as a retainer.

It may be considered that in the foregoing scheme I have taken very great liberties with the revenues of Great Britain in providing for the arming, equipping, and paying of *colonial forces*, but from my stand-point of an united Empire no such consideration should avail. If Great Britain *is* an Empire, its colonies are constituent parts of that Empire; and waiving the political questions of such an union, there can be no doubt but that, in event of war, the Empire is collectively bound against its enemies. The history of Great Britain shows that in all great wars its arms have been supported by mercenary troops,—paid and subsisted for the purpose of fighting its battles. The extension of its population renders the employment of mercenaries unnecessary; but the exigencies of the times demand that great armies shall be immediately available to meet the requirements of modern warfare. Why stint the colonies of the means which are necessary in order to enable them to bear their share of the burden of war? Why allow ships of war to rot in dry docks or in harbours without crews, when they might form schools for the training of a powerful auxiliary navy? The *British taxpayer* is the "bugaboo" that has always stood between the motherland and the colonies; but it is the growing belief that this unreasoning person has ceased to exist,

and that the Empire recognises no difference between the parent stock and its offshoots, and that the day is at hand when Imperial questions will be considered from an Imperial stand-point.

Names, Guns, and Complement of North American and West Indian Squadron.

	Guns.	Men.	
"Albicore," gunboat (tank-vessel)	2	40	Tender to "Terror."
"Argus," sloop.....	5	177	
"Bellerophon," ship, ironclad.....	15	550	Flagship.
"Blanche," corvette	12	200	
"Boxer," composite gun-vessel	4	73	
"Contest," „ „	4	59	
"Druid," corvette	14	226	
"Flamingo," composite gun-vessel.....	3	100	
"Griffon," „ „	3	100	
"Heron," gunboat	1	40	Tender to "Urgent."
"Northampton," ship, ironclad	12	553	
"Plover," gunboat.....	3	90	
"Rocket," composite gun-vessel	4	72	
"Scorpion," turret, ironclad.....	4	72	
"Sirius," corvette.....	12	205	
"Tamar," troopship	2	213	
"Tourmaline," corvette.....	12	233	
"Zephyr," composite gunboat.....	4	57	
"Terror," Harbour, Bermuda, floating battery, ironclad.....	8	73	
"Urgent," Depôt, Jamaica	3	140	
	127	3,173	

Names of Vessels out of Commission suitable as Training and Harbour Defence Vessels for Canada.

Name.	Guns.	Tonnage.	H.P.	Proposed Station.
"Ant," gunboat, iron	1	245	28	Bay of Chaleur.
"Badger," „	1	245	28	Charlottetown, P.E.I.
"Blazer," „	1	245	28	Bay of Fundy.
"Bonetta," „	1	245	28	Cape Breton.
"Bullfrog," „	4	455	360	Lake Ontario.
"Cockchafer," „	4	455	360	Lake Erie.
"Espoir," „	4	455	360	Lake Huron.
"Royal Sovereign," turret-ship....	..	3,765	800	Quebec and St. Lawrence.

Table showing Regulars and Volunteers on North American and West Indian stations.

Station.	Regulars.				Volunteers, enrolled or active militia.				Population from which garrisons could be furnished.	
	Batteries of Artillery.	Companies of Engineers.	Regiments of Infantry.	Approximate number.	Troops of Cavalry.	Companies of Artillery.	Companies of Infantry and Rifles.	Approximate number.		
Bermudas	2	5	2	3,800	27	80	630	44,519	700,000	Canada.
Halifax	3	1	2							
Newfoundland	..	..	..	..	..	none		..	84,000	Should furnish *at least* 10,000 militia for garrison and coast duty.
West Indies	..	..	1		..	..	..	..	34,000	
Barbadoes	1	..	..	1,500	..	..	..	..	[1]	Collective population of group, of European origin, capable of bearing arms.
Jamaica	1	..	1	..	..	..	..	..	6,500[1]	
St. Catherine's	..	..	..	..	2	1	..			[1] It is curious that there are no active militia in the most populous islands. This should be seen to without delay. There should be at least 3,000 enrolled militia in the W. I. Islands, to furnish the requisite garrisons.
Tobago	..	..	..	..	..	..	2			
Trinidad	..	..	..	..	..	..	2	400	5,000	
Turks Islands	..	..	..	..	..	1	..		150	
Guiana	..	..	..	..	..	..	..	..	7,500[1]	
Honduras	..	..	..	..	..	..	..	..	200	
Other Islands	..	..	..	..	..	..	..	..		

Table showing available numbers of 1*st and* 2*nd Class Militiamen in Canada, and Numbers of Active Militia Enrolled and Drilled.*

Name of Province.	Total male population according to census of 1871.	1st Class Militia, according to enumeration in 1873, between 18 and 30.	2nd Class Militia, according to enumeration in 1873, between 30 and 45.	Total unmarried or widowers without children between the ages of 18 and 45 years.	Quota of active militia, authorized under scheme of distribution in 1870.	Number of active militia, authorized to perform annual drill in 1878.
Ontario	828,590	115,225	18,211	233,736	18,070	9,214
Quebec.....	596,041	69,020	9,053	78,053	14,382	6,583
New Brunswick	145,888	22,969	4,302	27,271	3,264	1,204
Nova Scotia.....	193,792	30,241	5,706	35,947	4,284	1,925
Prince Edward Island (1877)	48,363	8,240	1,396	9,636	5,000 Supplementary Militia Acts	317
Manitoba (1877)	29,280	3,048	981	4,029		180
British Columbia (1877)	33,240	2,981	1,143	4,124		146
Total.....	1,875,194	251,824	40,792	392,866	45,000	19,569

NOTICES OF BOOKS.

The Life of General Dumouriez. By A. von Boguslawski, Major and Battalion Commander in the 1st West-Prussian Grenadier Regiment, No. 6. In two volumes, with two Maps and three Plans. Berlin, 1879.

The well-known and talented author of "Tactical Deductions," and several other works of the same nature, has now turned his attention to another branch of military literature, and has given us the life of an eminent soldier and politician hitherto less thoroughly known than he deserves to be, hence very generally misunderstood or misrepresented; a man who played a prominent and important part in the stormy times of the great French Revolution, but whose actions, disappearing as he did from public life at a comparatively early age, and in a manner which excited, however undeservedly, the suspicion and hatred of his countrymen, were in great measure obscured by the long series of stirring events which followed, and were only remembered as those of a traitor.

Major v. Boguslawski has devoted himself, and we think successfully, to awaken a renewed interest in the subject of his narrative, to rescue his memory from neglect and his character from the obloquy to which it has so long been exposed. Not that, like many biographers, he is so much in love with his hero as to be blind to his defects, and to the mistakes which he at times may have committed; on the contrary, as stated in the preface, the narrative will show that the author is far from wishing to make Dumouriez out to be "one of those historical heroes who really

"require no biographer," for "this would neither be justified by facts nor credit-
"able to the writer's judgment."

Far from doing this, he took great pains to get at the truth by carefully sifting the materials before him, and he appears to have weighed the evidence on all sides with great industry and impartiality, though he cannot help showing his aversion to the Republican of every degree.

Dumouriez's autobiography, which gives the story of his life up to 1793, is the groundwork of Boguslawski's history, but "composed," as the latter remarks, "directly after the events of 1793, and valuable, doubtless, as a source of informa-
"tion, it yet suffers from all the defects common, as a rule, to books published in
"defence of the writer's own actions against party attack, and not taking a sufficiently
"broad view of the political situation. Whether purposely or otherwise, not only
"are many weighty matters passed over in silence, but others, again, are coloured
"'*pro domo*,' so that a wide margin must necessarily be left to the biographer, who
"must indeed often represent facts otherwise than shown in Dumouriez's memoirs."

But there was no lack of materials to assist the author in his judgment: firstly, the many historical works upon the French Revolution, more especially those of Sybel; secondly, when the library of Metz fell into the hands of the Germans in 1870, it revealed a treasure of old and forgotten documents hitherto unknown to the historian, and useful for the writer's purpose; thirdly, he gained access, thanks to Sybel's researches in the archives of the Paris and Berlin War Offices, to many papers of value, and previously inedited, including reports of the negotiations between the Duke of Brunswick and Dumouriez in 1792, together with the correspondence which passed between the latter and the Ministers of War, Beurnonville and Pache, also the letters of Miranda and Valence, the reports of Miranda and Champmorin to their Commander-in-Chief Dumouriez, and the account given by Colonel Mack of the negotiations between the French General and the Prince of Coburg. Lastly, he consulted Witzleben's "Life of the Prince of Coburg," and Jomini's works.

Thanks to this rich fund of materials, the author is able to give us a clear view of both the public and private life of Dumouriez up to the age of fifty-four, and particularly of the last three years of the period, which were the most eventful in his history, as well as those most open to controversy The remaining thirty years of his life were passed in exile and in comparative obscurity.

The records preserved of the latter period are but meagre, and only sufficient to give us a general idea of the illustrious Frenchman's unflagging mental activity and of his unshaken patriotism.

The author owns that he is indebted to his friend, Colonel H. A. Smyth, Royal Artillery, and to the Incumbent of Henley-on-Thames, for much that he was able to learn about the last twenty years of the General's life, which were, as is well known, passed in England.

Major v. Boguslawski has given us a work which is interesting and instructive to the student of both military and political history, one which indeed treats of a bygone state of things, whether viewed from the standpoint of the soldier or of the statesman, but none the less important to the learner of the present day, for it gives him a glimpse of the end of an old era, and of the beginning of a new one not so far removed from us, together with a vivid picture of the disorder and disorganization more or less inseparable from a state of transition, whether the change be working in a nation or only in an army.

The author's style is easy and flowing, clear and vigorous, entirely free from the obscure and involved sentences which often make the works of his countrymen, however valuable, rather hard reading. The critical remarks upon the strategy and tactics of the campaigns of 1792 and 1793 are especially valuable.

It may be well, before concluding this notice, to remind our readers of some of the principal events of Dumouriez's life, certainly one of the most eventful and varied on record.

Charles François Dumouriez was born on January 25th, 1739, at Cambray. He took part in most of the campaigns of the Seven Years' War; was then engaged in Corsica, Spain, and Poland, both as a soldier and as a politician. In the last-named country he was undeniably the heart and soul of the resistance to Russia before the

first partition. Later on he took an active part in political intrigue at the Court of Louis XV, and ran great personal risks from his independence of character and want of courtier-like servility. These qualities, however, served him well, for they saved him from degenerating into a mere adventurer. When the great Revolution broke out he declared himself for political freedom and Constitutional government, showing an equal aversion to the despotism of a Sovereign or of a party. He tried hard to save first Louis XVI's throne and afterwards his life. For a short time Minister of Foreign Affairs, he strongly opposed foreign interference in France; afterwards, as Commander of a large portion of the French Army, he reorganized it, raised its *morale*, revived the warlike spirit of the nation, and notwithstanding the almost total absence of discipline amongst the new levies, the demoralized condition of the old regiments, the want of a trained staff, and of almost every requisite for enabling a modern army to take the field; notwithstanding, above all, the factious opposition of his political enemies, he made head against the veteran troops of the Coalition, and arrested at Valmy, on the 20th September, 1792, the invasion, against which resistance, under the circumstances of the moment, appeared at first sight hopeless.

Having, in the Argonnes Campaign, distinguished himself by the patience, coolness, and stubbornness of his defensive action, he showed no less dash and enterprise in the invasion of Belgium which followed, gaining the hard fought battle of Jemmapes on November 6th, 1793. This victory led to the complete conquest of Belgium, when Dumouriez strove to gain for France the affections of the Belgian people, by his moderation and justice, but was powerless in opposition to the Jacobins, whose oppressive acts made the French name hateful. Dumouriez now planned the conquest of Holland, but was interrupted in the course of his preparations by the advance of the Austrians and the defeat of the French troops guarding the Belgian frontier.

Concentrating his forces as far as possible, he fought the Battle of Neerwinden on March 18th, 1793. Completely defeated, he saved the remains of his army by his great coolness and personal courage, and made a creditable retreat. Having now, however, lost all hope of first completely vanquishing the foreign enemy, and of then using his victorious army to rescue France from anarchy and to restore Constitutional government, for such had all along been his firm intention, he strove to attain his patriotic end by help of the foreigner, and entered into negotiations with the Austrian Commanders, which led to the evacuation of Belgium by the French, and shortly after to the *pronunciamiento* of Dumouriez and to his flight to the Austrian head-quarters. This act, the motives for which will be found fully and ably discussed in the work before us, made Dumouriez hateful to the Republicans, with the exception of the few who understood and believed in him, without reconciling to him the Royalists who distrusted him, because they knew him to be an enemy to despotism, the only form of royalty within their comprehension.

A price was put upon his head by the National Convention, and he was proclaimed a traitor.

He declined to serve against France and never again engaged in public affairs, but retained to the end of his long life his deep interest in the events of the day, and was intimate with many of the leading statesmen of the time, some of whom frequently consulted him. He lived till 1804 at Altona, then took refuge in England, which he did not again leave, settling at Henley-on-Thames, where he died on March 14th, 1823.

From the time of his downfall he devoted much time to literary pursuits, writing the memoirs before alluded to, also many political pamphlets and articles upon current events. Some of these are very remarkable for the political acumen of which they give evidence. In proof of this, I will take leave to quote a passage from a letter written by Dumouriez to the Duc d'Orleans, afterwards Louis Philippe, in 1819, and published with many other papers from the same pen in 1835, under the title of a "Coup d'œil Politique sur l'Europe." Talking of the Turkish Empire, the writer remarks that it "must now gradually fall to pieces. "Russia will try to get the Bosphorus but in vain, as Austria will oppose it. A "partition of the Empire by these two Powers exclusively will meet with insuper- "able difficulties. *England will not allow it, unless herself firmly established in the "islands of the Archipelago. The first step towards such a partition will be the*

" *establishment of Russian predominance in Moldavia, Wallachia, and Bulgaria,* " *that of Austria in Bosnia, Herzegovina, and Servia.* The first danger to Turkey, " however, will come from Greece."

We cannot finish our brief notice of this important work better than by quoting the author's summing up of his hero's character, which is also the concluding passage of the book:—" The crooked paths of policy which it was his lot to follow " did not spoil his character. His daring courage, his high sense of honour, his " leaning to the Great and the Good remained unchanged, but so, also, did the " habits which he had acquired under the old *régime*, and which gave a handle to " those who attacked his private life. His motives and aspirations were pure, and " he always pursued a consistent course, keeping his object steadily in view, but " being hampered by old prejudices and brimful of ambition, he, like most other " men similarly placed, missed his way in the revolutionary labyrinth and sometimes " went astray. This was enough, amidst the whirl of party struggle and of " political conflict, to cast a shadow upon his fair fame, though he is far less " deserving of censure than many others over whose weaknesses and errors history " has spread her veil.

" Condemned to exile whilst still in the full vigour of life, endowed with restless " energy, capable of exercising a great influence over the future of his native land, " unjustly attacked by the great majority of men, misunderstood and scorned, he " fully expiated any faults of which he may have been guilty, and posterity, above " all his own country, which he saved in 1792, and the honour of whose arms he " revived, should not allow his great qualities to be any longer obscured.

" The prepossession in his favour which I, a foreigner, have shown by thus devot- " ing myself to the study and description of his deeds, may serve to confirm the " application of the motto which he appended to the memoir of his life,"

" *Non omnis moriar.*"

L. G.

On Coast Fortifications and the Naval Attack of Fortresses. By Major Arthur Parnell, R.E.

Major Parnell sends us, in pamphlet form, a paper which originally appeared in No. 10, Vol. II, Occasional Papers, Royal Engineers' Institute, Chatham, 1879.

His article is full of important matter, and most suggestive alike to those who build and fight our ships, to those who construct and man our fortresses, and to the general public who pay the bills. If Major Parnell is right in his views on the attack and defence of naval fortresses, our fortifiers have been going on a wrong tack, and much that they have done should be undone. No doubt the attention of his brother Officers is directed to the subject, which will receive ample discussion.

The following remarks, communicated to us by an Officer whose opinion bears great weight with the profession, will be read with interest, dealing, as it does, with the question from the naval point of view.

L. G.

There is a great deal of useful thought in Major Parnell's paper, and it is quite worthy of the attention of the Navy, although in some points their attention may result in disagreement with the author. There is one opinion on the naval attack of fortifications which is almost axiomatic amongst naval authorities, namely, that success of ships against forts depended in former times, and still depends, on the question of distance. If a sufficient number of ships can open fire on a fortress at close quarters, it has always been held that a fortress will fall. Or, on the other hand, if the fortress is so placed that ships cannot attack it at close quarters, it is held that the attack ought not to be attempted by ordinary war ships. The failure—if what was only intended as a diversion could be said to terminate in failure—of the ships to make a greater impression on the forts at Sevastopol is, in the naval world, attributed simply to the distance at which the ships engaged. Probably, on this head, Rear-Admiral Hamilton truly represents naval opinion in his paper on the

"Naval Operations during the Civil War in America,"[1] and he does not disguise an opinion that the success of the Federal ships against the Confederate forts was not accidental, but will be repeated whenever forts are so placed as to be fairly open to naval attack.

But it must be remembered, on the other hand, that the ships of the English Navy are prepared not for the attack on forts, but for fighting with corresponding structures at sea; and though the Navy may agree with Major Parnell that "the "art of attacking fortresses is of the utmost importance to our Navy," it will hardly follow him in saying that "it is of a cogency at least as great as is the study of naval "tactics for engagements between squadrons." The naval view would be that after the art of fighting at sea is fully mastered, attention may be properly given to the attack on fortresses, and the reason would be plain—it will be always possible for the Navy to abstain from attacking a fortress; a squadron may be forced to defend itself against a hostile squadron.

Besides this, we must recollect that our attacks upon fortresses will not be attacks on fortresses in general, but efforts against particular structures whose position and circumstances we know when war breaks out. Our studies would lead us not to the employment of our war-ships in designs for which they were not primarily intended, but to the construction of appliances suitable for the particular purposes we have in view. The best instances are found in the construction of gun and mortar boats, and finally of floating batteries, during the Crimean War.

But Major Parnell's view of the function of sea fortification in connexion with war-ships, and of the difference of this function which exists between the English and other nations, will meet with almost universal approval from the Navy. "Fortification," he says, "is merely a form of economy. It enables us to secure our "ports, money for money, in the most efficient manner, and it allows the whole of "our ships to be free to be used in their most advantageous form, *i.e.*, in a form "involving motion; in other words, in offensive fighting."

So also would a large, and perhaps a growing naval opinion, endorse the following sentences:—

"The policy of our establishing ships for the mere purpose of coast defence seems "undoubtedly erroneous. Mastless turret-ships, such as the 'Thunderer' and "'Glatton,' and others of great resisting strength, but not so well adapted for ocean "cruizing, should rather be styled coast attack ships, and should be reserved for the "express purpose of attacking fortifications, for which they appear to be in most "respects well suited."

The "Thunderer" is, no doubt, in quite a different category from the "Glatton," but the author's meaning is clear, and moreover there is reason to believe that, in the classification which is officially employed, the "Glatton," "Hotspur," "Gorgon," and her fellows, are treated as the author would have them. If it is at all lawful to prepare in a general way for the naval attack of fortresses, small but heavily-plated turret-ships, with heavy guns on a light draught of water, appear to be very legitimate objects. They take time to prepare, and cannot be rapidly turned out in numbers, like the unarmoured gunboat.

Where Major Parnell lays down the proposition that the modern ironclad is more liable to be sunk—that is, by projectiles—than her prototypes, he is, perhaps, taking a step in advance of ordinary naval opinion. The point is still possibly in the region of dispute as to the fact, but there is no doubt that a modern ironclad will put herself into positions with respect to forts which the Commander of her wooden predecessor would never have dared to occupy.

In his remarks on the relative want of accuracy of naval gun-fire, Major Parnell is probably supported by the facts, but it ought never to be forgotten by the engineer that a coast battery, which can be approached to short range by ships, has thrown away the superiority which a steady platform affords its fire.

So, also, in his remarks upon submarine mining, he is probably in agreement with the best naval opinion, which tends to a continual simplification of electrical systems which are in themselves complex and delicate.

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[1] Journal of the Royal United Service Institution, vol. xxii, p. 612.

Practically, in his summary of the methods to be adopted in the "Naval Attack "on a Fortress," Major Parnell suggests most of what can be suggested on the question. But it is a little curious that he should put forward so many theses which are in opposition to ordinary naval opinion. Thus he condemns mortar-boats and curved fire generally, notwithstanding our large use of them during the Crimean War; he condemns the small unarmoured gunboats carrying single heavy guns at a time when it is almost certain that we should build them in large numbers at the outbreak of a European war. He condemns the attack by ships in motion, where there is probably not any naval opinion with him. On the other hand, he is in complete accord with naval opinion in recommending the closest action for ships.

Altogether, the paper is one which may be usefully studied from all points of view.

P. H. C.

On a Proposed Limber System for Field Artillery. By Major W. B. Ellis, R.A.

THIS pamphlet is one of the many signs of the ever-increasing professional activity of the regimental Officers of the Army. Time was, and not so very long ago, when improvements in *matériel* or equipment were originated only within the departments concerned, or by clever theorists who had little practical knowledge of the subject. It is not to be wondered at, that, under such circumstances, progress was slow, for officials, buried under a mass of continual work, have little inclination to provide themselves with new labours, and it is easy to checkmate theorists. When, however, the general sense of a profession is moving in one direction, it is hard to resist it. When the practical men who have to work the tools are dissatisfied with them, and give their minds to improving them, reform cannot be far off.

It seems to us this is now the case in the field artillery. The increase of power in small-arms, and the comparatively small effect of artillery in the Russo-Turkish War, have given artillerists much to think of. Each brings his own idea to the common stock, and the unfailing result will be to give a new departure to Field Artillery, and carry it over all obstacles into a new channel of depth and force worthy of its old achievements.

The proposal of Major Ellis relates to one of the elements of progress, and we are glad to see he has renewed at this time an idea of which he was the early pioneer.

It is in effect the improvement of the gun limber, and the substitution of two similar limbers (one with four horses, and one with two) for the present ammunition waggon. There would thus be three limbers with each sub-division, interchangeable. Each of the proposed limbers carries 48 rounds, so that with the ammunition in the axletree boxes each 9-pr. gun would have, in the field, the same number of rounds now carried with the gun and waggon, but the gun would have 12 rounds more in its limber than it now has.

The question in this aspect, therefore, seems to become one between four-wheeled carriages and two-wheeled, or between waggons and carts. Carts have some disadvantages, viz.:

Increased length of column of route, not to any great extent, but enough to form some objection.

More shaft horses are required, and it is already a difficulty to get them. The weight per horse, with two horses in the limber, about 8½ cwt., seems rather excessive for work in the field, especially as the forward limber, which is normally to have four horses, is likely to fall short by casualties, and would then have difficulty in keeping its place.

These are some of the objections on the surface of the proposal; they, however, only require to be met, and the general principle of carts for ammunition is probably sound.

At all events, the present pattern of ammunition waggon is obsolete. We should be glad to see the inventive power of the country called on to produce a field gun carriage and ammunition carriage. Nothing is more wanted; it is the need of a

good carriage which more than anything else keeps back field artillery. The gun is far ahead of the carriage, and perhaps both are ahead of the ammunition carriage. The weight of 100 rounds of 9-pr. ammunition is about half a ton; surely the carriage need not exceed another half ton.

Space does not allow us to follow Major Ellis into further detail of his proposal; but the best thanks of all who wish for progress is due to those who, like him, raise these practical questions, and though they may meet with little encouragement at first, the time will come for their ideas to bear fruit.

W. A. F. S.

ROYAL UNITED SERVICE INSTITUTION.

DESIGN.

THE promotion of Naval and Military Art, Science, and Literature is the object of the ROYAL UNITED SERVICE INSTITUTION.

The principal means by which this object is sought to be obtained are—a Library containing Historical, Scientific, and Professional works;—a Topographical Room with Maps, Charts and Plans;—a Museum for objects illustrative of the progress of Naval and Military Art among all nations, for Trophies, and Relics, for Mementoes of distinguished Officers, or of remarkable Naval and Military events, and for the Exhibition of Inventions;—a Theatre where papers on professional subjects are read and discussed,—and finally, a Journal, published periodically, by means of which such papers and discussions are circulated among the members of the two Services, both at home and abroad.

BYE-LAWS.

SECTION I.

1. There shall be a Patron and Vice-Patrons.
2. PATRON: The Sovereign.
3. VICE-PATRONS: Members of the Royal Family: Distinguished Officers, and Members who have been benefactors to the Institution, to be selected by the Council.
4. The following Public Officers shall be Vice-Patrons during their continuance in office:—

1. The First Lord of the Treasury.
2. The Secretary of State for the Home Department.
3. The Secretary of State for Foreign Affairs.
4. The Secretary of State for the Colonies.
5. The Secretary of State for War.
6. The Secretary of State for India.
7. The First Lord of the Admiralty.
8. The Commander-in-Chief of Her Majesty's Forces.
9. The Lord-Lieutenant of Ireland.
10. The Viceroy and Governor-General of India.

SECTION II.—Composition.

1. Princes of the Royal Blood; Lords Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Her Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, Royal Naval Reserve, and Volunteer Corps, shall be entitled to become members *without Ballot.*

2. Ex-Governors of Colonies and Dependencies; Retired Officers; Deputy Lieutenants of Counties; Civil Functionaries who are or have been attached to the Naval and Military Departments; the Master, Deputy-Master, and Elder Brethren of the Trinity House; and Army and Navy Agents; shall be *eligible* to become Members by *Ballot.*

3. Gentlemen above the age of *fifteen*, whose names are on the List of the Commander-in-Chief for Commissions in the Army, or who are probationary for offices connected with the Naval and Military Professions, shall be *admissible*, by *Ballot*, to become Provisional Members from year to year, on payment of the Annual Subscription; and after they obtain their appointments, they may become Ordinary Members on payment of the Entrance Fee.

4. The names of the Candidates referred to in Articles 2 and 3 shall be submitted to the Council for election by Ballot; such Candidates must be recommended by Two Members of the Institution on their personal knowledge. The Lists of the names, signed by the Secretary, shall be put up in the Library or Reading Room Fourteen Days before submission to the Council.

SECTION III.—Honorary Members.

1. The Council shall have the power of admitting as Honorary and Corresponding Members, the Members of the Diplomatic Corps; Foreign Naval and Military Officers; Foreigners of distinction; other eminent Individuals, and Benefactors to the Institution, not otherwise eligible.

2. The Diplomatic Corps shall be privileged to submit to the Council the names of foreign noblemen and gentlemen, resident in England, in order that they may be elected Honorary Members during their stay in this country.

3. Ladies who contribute to the Institution may be admitted as Honorary Members.

SECTION IV.—GOVERNMENT.

1. The Government shall consist of a President and Twelve Vice-Presidents, and a Council composed of Twenty-four Members.

2. THE PRESIDENT OF THE INSTITUTION shall be elected by a General Meeting of the Members, and shall be a Member of the Council, *ex-officio*.

3. The VICE-PRESIDENTS shall be elected by the Council, of which they shall be *ex-officio* Members.

4. THE COUNCIL shall be elected by the General Meeting. Eight Members shall go out annually by rotation; Three of the Members going out shall be eligible for re-election. The Council shall submit to the Annual General Meeting a list of not less than ten names from which the vacancies may be filled. Vacancies that occur during the year shall be filled up by the Council, the Members so elected going out by rotation as the Members would have done, whose position they have been elected to fill.

5. After the annual meeting the Council shall elect a Chairman and Vice-Chairman for the ensuing year; one of whom, or a Vice-President, shall preside at its meetings, except when the President of the Institution attends.

6. Five Members of the Council shall constitute a quorum.

7. The Council shall have the custody of the Common Seal of the Corporation, and shall have full power and authority to affix the same to all deeds, documents, papers, and writings in the name and on behalf of the Corporation.

8. The Council shall appoint a Secretary and Curator, and such other officers, attendants, and servants, as they shall think necessary; with full power to suspend or dismiss the same: and no such officer, attendant, or servant shall, either directly or indirectly, accept, receive, or take, from any person or persons whatsoever, any gratuity, fee, or reward whatsoever, other than and except the salary, wages, or emolument allowed by the Council.

9. Such officers, attendants, and servants shall devote their whole time, during office hours, to the Institution, and shall not be permitted to be in any way connected with any other Institution or employment, unless the sanction of the Council thereto shall have been previously asked for and obtained.

SECTION V.—Subscription.

1. An Entrance Fee of One Pound shall be paid by all Members on joining the Institution, whether as Life Members or as Annual Subscribers.

2. Members who have joined previous to the 1st of January, 1870, pay, either—

1st. One Pound annually, or Nine Pounds Life Subscription.

Either of these payments entitles Members to receive the Journal; or,

2ndly. Ten Shillings annually, or Six Pounds Life Subscription.

These payments do not entitle Members to be supplied with the Journal.

3. On application in writing to the Secretary, the first of the above two classes of Members, may, when serving abroad, reduce their Annual Subscriptions to Ten Shillings, and still be entitled to receive the Journal: such reduced Subscriptions to commence on the 1st of January following their departure from the United Kingdom. The Members in the second class, while serving abroad, may, on applying in writing to the Secretary, be supplied with the current Numbers of the Journal, without increasing their Subscriptions.

4. All Members who have joined the Institution on or after January 1st, 1870, shall be entitled to receive the Journal from the date of their becoming Members, and, whether at home or abroad, shall pay One Pound annually, or Nine Pounds Life Subscription.

5. The first Annual Subscription shall be due on the day each Member joins the Institution, and the subsequent Subscriptions on the 1st of January in each year; but Members joining on or after the 1st of October in any year, shall not be required to pay the ensuing Annual Subscription on the 1st of January.

6. Members failing to pay their Annual Subscriptions after repeated applications, shall have their names removed from the List of Members at the discretion of the Council.

7. Members whose names have been struck off for non-payment of their Subscriptions, shall be re-admissible only on payment of all arrears from the date of the last payment.

8. The Journal and the Proceedings of the Annual General Meetings shall be sent post free; the Journal, to such Members as are entitled to receive it; the Proceedings, to every Member of the Institution.

SECTION VI.—Funds and Expenditure.

1. The management of the property, receipts, and payments of the Institution shall be confided to the Council, who shall authorise every payment by an order signed by the Chairman at the Meeting, and by another Member of Council present, and countersigned by the Secretary.

2. The Royal United Service Institution neither shall nor may make any dividend, gift, division, or bonus in money, unto or between any of its Members out of its present property, or out of any property which it may hereafter acquire; and the whole of its property, both present and future, shall be exclusively applied for carrying into effect its design as an establishment for the promotion of Naval and Military Art, Science, and Literature.

3. The funds of the Institution and all Life Subscriptions and Legacies shall be invested in the name of the Corporation in eligible securities, to be selected by the Council.

4. All cash received on behalf of the Institution by the Secretary shall be paid by him to the Bankers of the Institution.

SECTION VII.—Auditors.

1. There shall be Three Auditors, not Members of the Council, who shall be elected by the Annual General Meeting to audit the accounts, one of whom shall go out annually by rotation, but shall be eligible for re-election.

2. Two Auditors shall form a quorum.

3. Any Vacancy that occurs otherwise than by an Auditor going out by rotation, shall be filled up by the Council; and the Auditor so elected, shall go out in the same order of rotation as his predecessor.

4. The Auditors shall examine and sign the yearly accounts, adding any remarks, and making such inquiries as they may deem proper.

5. After the Audit, and at least Fourteen Days before the Annual General Meeting, the Annual Report, with an abstract of the accounts, and estimate of the probable receipts and expenditure for the ensuing year, shall be printed and placed in the Library and Reading Room, and may be obtained by Members on application to the Secretary.

SECTION VIII.—General Meetings.

1. A General Meeting shall be annually held on the first Saturday in March; that day being considered the Anniversary of the Institution.

2. The Council may call a Special General Meeting, on giving fourteen days' notice—which notice must be suspended in the Library or Reading Room, and advertised in two military papers, specifying the subject to be brought forward, to which subject the discussion shall be strictly limited.

3. The Council shall call a Special General Meeting on the written requisition of not less than Twenty-four Members, within one calendar month from the date of such requisition, subject to the notices and restrictions above mentioned.

4. At the General Meetings, in case of an equality of votes, the Chairman shall have a second or casting vote.

5. Any Member who is in arrear with his Subscription, shall be disqualified from speaking or voting at any General Meeting, or at any Special General Meeting, or at any adjournment thereof.

6. Any General or Special General Meeting, finding the current day insufficient for its intended purpose, may adjourn to the succeeding or any future day or days, until the business be concluded.

7. No business shall be transacted at any Annual General Meeting other than that submitted by the Council, or by the direction of the Council, unless notice thereof be suspended in the Library and Reading Room at least Fourteen Days prior to the day appointed for such Annual General Meeting, specifying the subject to be brought forward, to which subject the discussion shall be strictly limited.

SECTION IX.—Making or Repealing Bye-Laws.

Should it be proposed to make, alter, or repeal a Bye-Law, the proposition to such effect, signed by the proposer and seconder, shall be suspended in the Library and Reading Room for Fourteen Days; after which the question shall be determined by a majority of at least two-thirds of the Members present at the next General Meeting.

SECTION X.—Mode of Voting.

All questions shall be decided by a show of hands, unless a Ballot be demanded.

SECTION XI.—Hours of Reception—Visitors.

1. The Museum of the Institution shall be open daily (Sundays excepted) from 11 to 5, from April to September inclusive, and from 11 to 4, from October to March inclusive. Printed tickets for the admission of Visitors are available for every day except Friday, on which day a personal introduction by a Member is necessary.

2. The Libraries and Reading Rooms shall be kept open (Sundays excepted) for the use of Members only, till 8 in the evening, or to a later hour, at the discretion of the Council.

3. The Museum shall be closed to Visitors when necessary, at the discretion of the Council.

SECTION XII.—Expulsion.

1. In case the Council shall think it expedient to submit the conduct of any Member to the judgment of a General Meeting, the Council shall call a Special General Meeting; and in the event of a majority of two-thirds of the Members present at such Meeting, deciding on his expulsion, such Member shall cease to belong to the Institution.

2. Any Member who shall be removed from the Public Service for causes affecting his character shall, if the Council so decide, cease to belong to the Institution.

3. In either of the above cases, the Member so expelled shall forfeit all claims on the Institution.

A BRIEF DESCRIPTION

OF THE

Royal United Service Institution.

THIRD EDITION.

1873.

Published under the Authority of the Council.

THIS Institution was founded in 1831, under the auspices of King William the Fourth, and under the patronage of the Duke of Wellington, and of some of the most distinguished Naval and Military Officers, at that time, in the service of the Country.

In 1860, Her Majesty the Queen was graciously pleased to grant to the Members of the Institution, a Royal Charter of Incorporation, under the title of THE ROYAL UNITED SERVICE INSTITUTION.

DESIGN.

The design of the Institution is to promote Naval and Military Art, Science, and Literature.

The above object is carried out by means of a Library; the delivery of Lectures; the exhibition of Inventions; the publication of a Journal; a Museum containing Naval and Military Models, a collection of Arms of all Nations, Relics of, and Trophies connected with, distinguished Officers and warlike operations; and other objects affording professional information.

QUALIFICATION OF MEMBERS.

The following Officers are *entitled* to become Members *without ballot*, on payment of their entrance fee and subscription, viz.,

Princes of the Blood Royal; Lords-Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Her Majesty's Indian Naval and Military Forces, Militia, Yeomanry, Royal Naval Reserve, and Volunteer Corps.

The following are *eligible* to become Members, by ballot, on their names being submitted to the Council by two Members of the Institution, viz:—

Officers, not previously Members, who have retired from the Service; Ex-Governors of Colonies and Dependencies; Deputy-Lieutenants of Counties; Civil Functionaries who are, or have been attached to the Naval and Military Departments; also the Master, Deputy-Master, and Elder Brethren of the Trinity House, and Army and Navy Agents.

Privileges of Members.

Members, non-resident in the United Kingdom, are entitled to an Absent Member's ticket (not transferable), which will admit their friends to the Museum and to the Theatre. The name and address of the person to whom the ticket is given, should be transmitted to the Secretary and will appear on the ticket. This ticket must be renewed at the commencement of each year.

Members are entitled to as many ordinary tickets of admission to the Museum as they may from time to time require, such tickets being available for every day except Friday, on which day Members must personally introduce their friends.

Members have the privilege of admitting two friends to the Lectures or Evening Meetings, either by personal introduction, or by ticket, except on special occasions, of which due notice will be given.

Members can receive and answer letters at the Institution.

Honorary Members.

Honorary Members are only entitled to personal admittance to the Institution.

Subscription.

An Entrance Fee of One Pound.

An Annual Subscription of One Pound, or a Life Subscription of Ten Pounds (including Entrance Fee).

Subscriptions are due on joining the Institution, and on the 1st of January in each year.

When a Member joins the Institution on or after the 1st of October, he will not be charged a second Subscription on the following 1st of January, but on the 1st of January thereafter ensuing.

The Theatre.

Lectures and Evening Meetings.

Lectures are delivered in the Theatre of the Institution, on alternate Fridays, at 3 p.m., and Papers, followed by discussions, are read at the Evening Meetings, on alternate Mondays, at 8.30 p.m., from January to June inclusive.

The Council are anxious that Officers (particularly those on Foreign Stations), should contribute Papers, descriptive of Countries or Warlike operations, or containing other Professional information.

A very important advantage conferred by the Institution upon the Services and the Public, is, the opportunity which it affords to Officers and others, of bringing forward in the theatre, schemes of improvement of a professional character, which might otherwise fail to receive the attention which they deserve. Inventors of articles connected with the Naval and Military Professions have also opportunities granted them of exhibiting their inventions at the Evening Meetings, and of depositing models of them in the Institution.

Societies and Charitable Institutions, connected with the Army and Navy, are allowed the privilege of holding their General Meetings in the Theatre of the Institution, subject to the discretion of the Council.

The Journal.

The Journal, published under the authority of the Council,

contains the Lectures, the proceedings of the Evening Meetings (and a description of the inventions then exhibited), illustrated, when necessary, by Maps and Diagrams.

This publication, now amounting to 16 annual volumes, has proved eminently successful, and has been received with marked approbation by the Members and by the Public. It is sent, post free, to Annual Subscribers of One Pound, and to Life Subscribers of Nine Pounds.

Officers joining the Institution on and after the 1st October, are only entitled to the numbers of the Journal published subsequent to that date.

The Library.

The Library contains 16,700 volumes of Professional, Historical, and Scientific Works. Amongst these, is a complete set of the Specifications of Patents connected with Arms, Ammunition, and Accoutrements, commencing from the year 1617, together with Abridged Specifications of Inventions in various other Departments of Science. This valuable series was presented by H.M.'s Commissioners of Patents.

The Governments of Austria, Belgium, Denmark, France, Italy, the Netherlands, the North German Confederation, Russia, Sweden, Switzerland, and the United States present their professional journals; and the Admiralty, the War, and the India Offices supply the Parliamentary Papers, and other documents issued by them.

The Library has been found most valuable for purposes of study and reference, and is extensively used by the Officers of H.M.'s Services.

In addition to the Library, there is a Reading Room, in which the leading Daily Papers; the Quarterly and Monthly Periodicals; as well as the Weekly scientific and professional Newspapers, are taken in.

The Library and Reading Room are open to Members from 10 A.M. to 8 P.M.

The Topographical Room.

This Room contains the Charts issued by the Admiralty; the

copies of maps, plans, &c., prepared by the Topographical Department, and the photographs of Ordnance, Military Matériel, &c., presented by the War Office; also a large and valuable collection of Maps, Plans of Campaigns, of Battles and Sieges, &c., &c.

During the progress of Military operations, the movements of the hostile forces are defined, by means of pins and coloured cards, upon Maps specially arranged for the purpose.

The Museum.

Naval Department.

In this Department, there is a Series of Models, illustrating the Naval Architecture of different Countries, and of early periods down to the present time. It also contains Models of Life boats (and other Apparatus for saving Life), Masts, Anchors, Rudders, &c., &c.

This Department also contains an elaborate model of the Battle of Trafalgar. The table upon which it is placed, and which was presented by the Lords of the Admiralty, was constructed of oak-timber removed from H.M.S. "Victory," when under repair.

Military Department.

The European Armoury contains specimens of Mediæval Armour and Weapons, also of Breech-loading Ordnance of an early date; a complete series of Firearms, in use by the British Army from the reign of Charles the Second to the present time; and an interesting collection of the Breech-loading Small Arms of different Countries.

The Foreign Armoury contains a rich collection of Arms and Armour from India, from China, and from Japan: also the arms of the Esquimaux, of the natives of New Zealand, Australia, Africa, North and South America, and of the Polynesian Islands.

The Military department of the Museum also contains a series of Models of the different patterns of heavy Ordnance and of Field Artillery in H.M.'s Services; of Guns invented by private individuals; and of the various forms of rifling which have, from time to time, been advocated. There are also here arranged, specimens of different kinds of Gunpowder, Fuzes,

Shot, Shell, Rockets, and other Missiles, with many other objects of much interest connected with the science of Gunnery.

Steam Engines.

The Institution possesses a very complete series of working Models of Steam Engines, for which it is indebted to Captain Jekyll, late Grenadier Guards.

Accoutrement Room.

This room contains specimens—presented by the respective Governments—of the Uniforms, Arms, Accoutrements, and Field Equipments of Soldiers of the Continental Armies, of the United States, and of Great Britain.

The Waterloo Room.

The Waterloo Room contains three historical Models of great interest, viz., the celebrated Model of the Battle of Waterloo, by the late Captain Siborne; of the South of the Crimea, and Siege of Sevastopol, by Lieut.-General Sir Frederick W. Hamilton, K.C.B., late Grenadier Guards; and of the Defences of Lintz, by Captain Staveley.

Military Model Room.

In this Room, there are elaborate Models of the Attack and Defence of a Town fortified on Vauban's first system; of Plymouth, with its detached Forts; of the "Lines of London," as planned by Colonel Sir Shafto Adair, Bart., F.R.S. (now Lord Waveney); of the Fortress of Metz and the surrounding country; of Paris and the German Lines of Investment in 1870–71; of the Battle Fields of Königratz; of Sedan-Beaumont, &c., &c.: there are also Models of the various systems of permanent fortification, of Field-works, Pontoons, Military bridges, Mining tools, Camp equipage; and many other objects of interest.

Trophies, Relics, &c., &c.

Amongst these will be found the Sword worn by Lord Nelson

at the capture of the "San Josef," some of his Autograph Letters, and other interesting Relics; the Chronometer used by "Captain Cook" when he sailed round the world; the Signal-Book of the "Chesapeake;" the Main Truck of "L'Orient," blown up at the battle of the Nile; with many others of a similar character.

The Museum also contains, besides several Presentation Swords, the Swords of "Cromwell" and "Wolfe;" the Sash by which "Sir John Moore" was lowered into his grave; "Napoleon's" Fusil, the skeleton of his charger Marengo, and other Relics; "Tippoo Sahib's" Pistols, and the Dress worn by him when he was killed; with Trophies from Waterloo, Sevastopol, Inkerman, and other places.

Geological and Mineralogical Collections.

As the sciences of Mineralogy and Geology are included in the Programme of Examinations for Commissions, and for Staff Employment, these Collections have been retained in the Museum. Candidates who are preparing for such Examinations, and Officers who are desirous of qualifying themselves for conducting Geological and Mineralogical surveys, will find them interesting and instructive.

Soldiers, Sailors, Policemen, and Volunteers in uniform, have free admission to the Museum. The public may obtain admission to the Museum by tickets, to be obtained of the Secretary.

Information respecting the Institution is advertised in the Weekly Professional Papers, and in the "Times" and other daily papers.

The Royal United Service Institution, under the patronage of Her Majesty, aided by the Government, and supported by the different branches of Her Majesty's Services has

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The Royal United Service Institution, under the patronage of Her Majesty, aided by the Government, and supported by the different branches of Her Majesty's Services has

now become a National Institution. It will seek in the future, as in the past, not only to cultivate the Sciences connected with the Profession of Arms, but also to concentrate in the Capital of the Empire whatever may tend to illustrate the Services of the Army and Navy of the Country.

B. Burgess, Captain,

Secretary.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HER MAJESTY, ST. MARTIN'S LANE.

ROYAL
UNITED SERVICE INSTITUTION.

Charter of Incorporation.

Victoria by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith, **To all to whom** these presents shall come, **Greeting:**

Whereas our right trusty and right entirely beloved Cousin and Councillor, Algernon Percy, Duke of Northumberland, Knight of the Most Noble Order of the Garter, Vice-Admiral, and others of our loving subjects, have, by their Petition, humbly represented unto us that they are Members of a Society, established in the year one thousand eight hundred and thirty-one, under the title of "The Naval and Military Library and Museum," but since called "The United Service Institution," of which His late Majesty King William the Fourth was the founder;

That such Society has sedulously encouraged

and extended Naval and Military Science and Literature, and that it would further tend to the promotion and advancement of Naval and Military Science and Literature if we granted to the said Algernon Percy, Duke of Northumberland, and to those who are now Members of the said Society, our Royal Charter of Incorporation;

Now know ye, That We, being desirous of encouraging a design so laudable and salutary, of our especial grace, certain knowledge, and mere motion, **Have** willed, granted, and declared, and **Do** by these presents, for Us, our heirs and successors, will, grant, and declare, that the said Algernon Percy, Duke of Northumberland, and such other of our loving subjects as now are Members of the said Society, or shall from time to time become Members thereof, according to such regulations or bye-laws as shall be hereafter framed or enacted, and their successors, shall, during such time as they shall respectively continue to be such Members, be by virtue of these presents one body politic and corporate, by the name of "THE ROYAL UNITED SERVICE INSTITUTION," and for the purposes aforesaid and by the name aforesaid shall have perpetual succession and a common seal, with full power and authority to alter, vary, break, and renew the same at their discretion, and by the same name to sue

and be sued, implead and be impleaded, answer and be answered unto, in every court of Us, our heirs and successors, and be for ever able and capable in the law to purchase, receive, possess, hold, and enjoy, to them and their successors, any goods and chattels whatsoever, and as well those as now belong to the said Institution as those which may be hereafter acquired; and also to be able and capable in the law (notwithstanding the Statute of Mortmain) to take, purchase, hold, and enjoy to them and their successors a Hall or House, and any such messuages, lands, tenements, or hereditaments whatsoever as may be necessary for carrying out the purposes of the said Society, the yearly value of which, including the site of the said hall or house, shall not exceed in the whole the sum of two thousand pounds, computing the same respectively at the rack-rent which might have been gotten for the same respectively at the time of the purchase or acquisition thereof; and to act in all the concerns of the said body politic and corporate as effectually, to all intents and purposes, as any other of our liege subjects in our said kingdom not being under any disability might do in their respective concerns.

And We DO HEREBY GRANT our especial licence and authority unto all and every person and persons,

bodies politic and corporate, otherwise competent, to grant, sell, alien, and convey in mortmain unto and to the said body politic and corporate and their successors, any messuages, lands, tenements, and hereditaments, not exceeding such annual value as aforesaid.

And Our will AND PLEASURE IS, and we do further will and declare, that there shall be Patrons and Vice-Patrons, and a President and Vice-Presidents, of the said Institution, and that the said Algernon Percy, Duke of Northumberland, shall be the first President under this our Royal Charter of Incorporation, and that not more than Twenty-four nor less than Twelve Members, to be chosen by a General Meeting of the said Society, shall be the Council of the said body politic and corporate, of which the aforesaid President and Vice-Presidents shall be ex-officio Members; and, until such Members of the Council shall be elected, the present Members of the Council of the said Institution shall be the Council of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That there shall be a General Meeting of the Members of the said Society once in each year or oftener, and that if necessary the same shall be adjourned from time to time, and that the said General Meetings and the Council shall have the entire direction and manage-

ment of the concerns of the said body politic and corporate, in the manner and subject to the regulations hereinafter mentioned.

And We DO FURTHER WILL AND DECLARE, That the said General Meetings shall from time to time make and establish such bye-laws, and vary, and alter, and revoke the same, as they shall deem to be useful and necessary, for the election of President, Vice-Presidents, and Council, and for the regulation of the said body politic and corporate, for the admission and expulsion of Members and of honorary and foreign Members, so that such bye-laws be not repugnant to these presents, or to the laws and statutes of this our realm; and shall and may also enter into any resolution and make any regulation respecting the affairs of the said body politic and corporate that may be necessary and proper, and shall not be repugnant to these presents, or to the said laws and statutes.

And We DO FURTHER WILL AND DECLARE, That the General Meetings and adjourned General Meetings shall take place at such time as may be fixed by the said Council, and that the present rules, regulations, or bye-laws of the said Society, so far as they are not inconsistent with these presents, shall continue in force until the same shall be altered by a General Meeting.

And We DO FURTHER WILL AND DECLARE, That notwithstanding anything herein contained, the Council shall have the sole management of the income and funds of the said body politic and corporate, the appointment of Secretary, Curator, and such officers, attendants, and servants as the Council shall think necessary or useful; and also the entire management and superintendence of all the other affairs of the said Society; and shall and may, but not inconsistently with or contrary to the provisions of this our Charter, or any existing bye-law or laws, or the laws and statutes of this our realm, do all such acts and deeds as shall appear to them necessary for carrying into effect the objects and views of the said body politic and corporate.

Provided always, and we do further will and declare, That the Council shall from time to time, and at least once in each year, render to a General Meeting a full account of their proceedings, and that every Member of the Society may at all reasonable times, to be fixed by the Council, see and examine the accounts of the receipts and payments of the said body politic and corporate.

And We DO FURTHER WILL AND DECLARE, That no sale, mortgage, incumbrance, or other disposition of any messuages, lands, tenements, or hereditaments belonging to the said body politic and

corporate shall be made, except with the approbation and concurrence of a General Meeting.

And We DO FURTHER WILL AND DECLARE, That it shall be lawful for the Council of the said Institution, with the approbation and concurrence of a General Meeting from time to time to appoint any persons to be Trustees of any part of the property of the said body politic and corporate, and to make, or direct to be made, any conveyance or transfer to such Trustees.

In witness whereof we have caused these our Letters to be made Patent.

Witness Ourself, at Our Palace at Westminster, this twenty-second day of February, in the twenty-third year of our reign.

By Her Majesty's command,

Edmunds.